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Adulterations Detected. 70

DEDICATION.

TO

WILLIAM SCHOLEFIELD, Esq., M.P.

Chairman of the Committee of the House of Commons
on Adulteration.

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ac

Sir,

Permit me to dedicate the following pages to you.

As Chairman of the Committee of the House of Commons on the subject of Adulteration, the community naturally look to you for assistance in protecting them for the future from the frauds to which they have been subject.

With the fervent hope that the facts adduced in this work may aid you in the cause with which your name is so closely and honorably associated,

I beg to subscribe myself,
Your obliged and faithful servant,
ARTHUR HILL HASSALL.

C.C.B.
CCb. h. 8

PREFACE.

THE present work is not intended to supersede my previous book, entitled "Food and its Adulterations;" the plans and objects of the two works being distinct.

The principal objects of the *first and larger work* were, and still are, to demonstrate the existence of extensive adulteration, in all the more important articles of daily consumption, as actually supplied by merchants and traders to the public; to show that adulteration largely affected the pecuniary interests of the consumer and the revenue; and that it was a question most seriously affecting the public health. These objects the work in question has fully accomplished.

As one of the results of my former investigations, the importance of the subject of adulteration has been recently officially acknowledged by the appointment by the House of Commons of a Select Committee to inquire into the matter. This Committee, under the able presidency of Mr. Scholefield, M.P. for Birmingham, zealously prosecuted its inquiries for two sessions of Parliament, and the result has been to confirm, to the full extent, the accuracy and fidelity of the investigations, in the prosecution of which, mainly through the medium of "The Lancet," I have been engaged for so many years. The Report of this Committee has been laid before the House. It acknowledges that adulteration widely prevails; that the evil requires to be dealt with by the Legislature; and it contains suggestions and recommendations for the suppression of adulteration.

The Committee state that they "cannot avoid the conclusion that adulteration widely prevails." "Not only is the public health thus exposed to danger, and pecuniary fraud committed on the whole community, but the public morality is tainted, and the high commercial character of the country seriously lowered both at home and in the eyes of foreign countries."

These are grave statements and admissions, made on the very highest authority.

The chief purpose of *the present work* is to furnish plain instructions, microscopical and chemical, embodying the results of extended practice and experience, for the discovery of adulterations in Food and Medicine.

To accomplish this object effectually, it will be necessary that the adulterations to which each particular article of consumption or drug is subjected, should be described in as concise yet clear a manner as possible. The treatise will therefore not be limited to a mere description of the methods by which adulteration may be discovered, but will contain much information in relation to adulteration in general.

The best method of putting a stop to adulteration is undoubtedly to destroy the security attending the practice of it.

The first step necessary for the accomplishment of this object is to supply the means requisite for the discovery of adulteration.

The happy application of the microscope to the subject of adulteration, has furnished the means of detecting a host of adulterations, the discovery of which had before, for the most part, been considered to be impossible; but still practical explanations and details are required to enable others to employ the instrument with advantage for that purpose; and the same remark applies to chemistry. Such necessary details and explanations, accompanied by a large number of microscopical illustrations, it is hoped will be found in the pages of this work, and that through its instrumentality, the many hundreds of microscopists and chemists scattered over all parts of the country, will be induced to apply themselves to the discovery of adulterations in articles of food and medicine, in the respective neighbourhoods and localities in which they reside. Should this anticipation be realised, "a heavy blow and great discouragement" will be inflicted upon all adulterators, for the security in which their proceedings were formerly conducted will be for ever destroyed.

The more frequent discovery of adulteration will doubtless lead, in many cases, to the publication of the names and addresses of the parties perpetrating it. It was this publication which contributed so essentially to the success of my reports in "The Lancet." By it direct responsibility was secured, the honest tradesman was distinguished from his unscrupulous competitor, and in many instances the offence of adulteration was brought home to the parties actually guilty of it.

This unparalleled proceeding was in the first instance, and when science had been but imperfectly applied to the detection of adulteration, attended with the utmost hazard, not only to Mr. Wakley, who suggested the publication of the names, and who incurred the legal risk attendant thereon, but also to myself, staking as I did reputation and prospects alike upon the issue of a most arduous and responsible undertaking.

In publishing the present treatise, and in thus supplying a public want, I am realising a suggestion for the suppression of adulteration which I made in evidence before the Select Committee on Adulteration, in July 1855, namely, that a cheap treatise on adulteration should be published, which "should be illustrated with wood-cuts showing the microscopical appearances and structure of the different articles, both genuine and adulterated, and containing plain directions for the discovery of adulteration."

The work to which I have given the title "Food and its Adulterations," comprises the Reports, carefully revised, of the Analytical Sanitary Commission of "The Lancet." These reports were published at short intervals in that periodical for a term of four years, commencing January 1851, and ending December 1854, and they contained 2387 analyses, of which 2063 were of articles of food, and 324 of drugs.

Of these analyses, which were for the most part both microscopical and chemical, 2222 were made by myself; and the reports being all written by me, I retain the copyright of them under a special agreement.

In the present work, the analyses above referred to are not given, but merely the general conclusions or results derived from those analyses; in addition to which, this work contains the results of the analyses of several hundreds of samples of articles of food and drugs which have never been published in "The Lancet," and the whole of which have been made by myself during the years 1855 and 1856.

Availing himself of a temporary misunderstanding between myself and Mr. Wakley, Dr. Letheby put forward, some time back, a claim of so exaggerated and incorrect a character for participation in the work of "The Lancet" Commission, which claim he attempted to support by the publication in "The Times" newspaper of extracts from my private and confidential letters addressed to him, that I, in justice to myself, consider it necessary to define once more in this place the extent and nature of the assistance rendered by Dr. Letheby.

Having been on terms of intimacy with him for some years, I employed him occasionally to make certain analyses both for myself and for "The Lancet," I sending him the samples, and indicating the particulars required. The results were in all cases returned direct to me, the analyses charged for and the accounts made out by Dr. Letheby in my name, he not holding, during the whole time or in a single instance, the slightest communication either with Mr. Wakley or with any person connected with "The Lancet."

The accounts and other documents furnished by Dr. Letheby having been fortunately preserved, they were submitted to the scrutiny of Mr. George Bolton, the Rev. R. S. Daniell, M. A., and others. The gentlemen whose names are given above drew up a Report, embodying the results derived from an examination of the accounts, &c., from which the following is extracted: —

"The accounts rendered by Dr. Letheby, being so clear and in his own handwriting, furnish indisputable and conclusive evidence of the actual number of analyses performed by him, some of them being partial analyses only. Thus it is distinctly shown that the entire number of chemical analyses performed by Dr. Letheby, viz. 165, bears but a very small proportion to the number of the analyses, as well microscopical as chemical, performed by Dr. Hassall, viz. 2481.

"Of these samples 63 were of tobacco and snuff, and 53 of opium; thus leaving 48 samples of all other kinds; but it is to be especially noted that the analyses of these 53 samples of opium are not recorded in Dr. Hassall's work on 'Food and its Adulterations.'

"As witness our hands this first day of August, One thousand eight hundred and fifty-five.

"RAYMOND S. DANIELL, M. A., Oxon.
"GEORGE BOLTON.

"9. Queen Street, Brompton."

It is perhaps necessary to state that in the new analyses, amounting to some hundreds, the results of which are recorded in this work, over and above the 2481 before alluded to, Dr. Letheby has had no part whatever.*

For the information contained in this work respecting the duties upon, and consumption of the various articles treated of, we are indebted to Mr. T. C. Kent, of Upton-on-Severn, and A. W. Fonblanque, Esq., of the Statistical Department of the Board of Trade, to both of whom we tender our sincere and cordial thanks for the aid thus afforded.

The author has spared no pains or expense to insure the fidelity and careful execution of the wood engravings. Of these about two-thirds were drawn on wood by Mr. Henry Miller, under the direct superintendence of the author, and the others by Mr. Tuffen West, with the exception of the figures of liquorice, which were drawn by Mr. Searson: they were all engraved by Mr. Hart of Gloucester Street, Bloomsbury Square. Nothing could exceed the care bestowed by each of the artists named upon the execution of the figures, and the author believes that no engravings of microscopic objects have hitherto been produced on wood superior, and but few equal, to those which will be found dispersed through the pages of the present work.

It is not a little singular that Mr. Miller and Mr. West, two of the best microscopic artists we have had, both commenced their careers as artists with the author. The first drawings from the microscope made by Mr. Miller, were for "The Microscopic Anatomy of the Human Body" about ten years since, from which time until his death, which occurred recently, he continued, except for a few short intervals, in the author's service. Mr. West also resided with the author for a time, and his first microscopical drawings were also for the work above mentioned.

Bennett Street, St. James's Street,
January 12th, 1857.

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* For a fuller refutation of Dr. Letheby's claim and exposure of his conduct, the reader is referred to a Pamphlet by James Cæsar Durnford, Esq., Barrister, John A. Power, L. M., M. A., Cantab. and Raymond S. Daniell, M. A. Oxon.; published by William Tegg and Co., 85. Queen Street, Cheapside.

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ADULTERATIONS DETECTED.

GENERAL INTRODUCTION.

In this Introduction the subject of adulteration will be considered in some of its more general and important aspects and relations: thus, amongst other points, what constitutes adulteration will be defined, its prevalence shown, a classification of articles employed for adulteration given, the importance of the subject explained, and, lastly, the means or remedies by which adulteration may be discovered and obviated considered.

Definition of Adulteration.

It may facilitate the clearer understanding of the subject to define at the outset what constitutes adulteration; but, before doing so, it may be well to explain what is not adulteration. This is the more necessary, since this part of the subject is involved in some degree of uncertainty and confusion.

The sale of one article in place of another is not an adulteration, but a substitution.

Again the presence of substances in articles in consequence of impurities contained in the materials out of which they were prepared, as, for example, of arsenic in the hydrochloric acid used in the preparation of unfermented bread does not constitute adulteration: they are simply impurities.

Lastly, the accidental presence of substances in any commodity does not constitute adulteration.

Excluding then from the class of adulterations all cases of *substitution*, of *impurities*, and accidental *contaminations*, adulteration may be thus defined.

It consists in the intentional addition to an article, for purposes of gain or deception, of any substance or substances the presence of which is not acknowledged in the name under which the article is sold.

It is not easy so to frame a definition as that it shall apply to every case: that now given does, however, most certainly embrace the great majority of adulterations practised, and it excludes substitutions, impurities, and accidental contaminations, because it specifies that the addition must be *intentional.*

According to this definition the sale of coffee containing chicory for and as coffee, of cocoa into which sugar and starch have been purposely introduced, and of mustard containing flour and turmeric, as cocoa and mustard, constitutes so many adulterations, and as such they ought undoubtedly to be considered.

The consumer entering a shop, and asking for any article, has a right to expect that he will be supplied with that which he demands, and for which he pays, and he ought not to be furnished with a mixture of articles not acknowledged in the name under which the mixture is sold, and the nature and proportions of the ingredients entering into which are often unknown to him. This right undeniably belongs to the purchaser, and any wilful violation of it constitutes adulteration.

The words coffee, cocoa, and mustard convey distinct ideas: these names have been bestowed upon certain vegetable productions,—coffee upon the berries of the coffee plant, cocoa and mustard upon the seeds bruised and reduced to powder of the cocoa and mustard plants: any application, therefore, of these words to mixtures and compounds is obviously improper, and in many cases is in a high degree deceptive.

The plea that the addition of chicory to coffee, of flour and sugar to cocoa, of turmeric and flour to mustard, as well as that numerous other additions, constitute improvements, ought not to avail. In nineteen cases out of twenty, these additions are no improvements at all; and where they really are so, the mixtures ought to be acknowledged, wherever practicable, in the names under which such mixed articles are sold; and not only ought this to be done, but the proportions of the several ingredients should be stated.

Even with such regulations it is questionable how far the sale of such mixtures ought to be permitted, except in cases where distinct advantages can be shown to result from them, because, in the present state of science, it is frequently impossible to determine the truth or falsehood of any statements which might be put forth respecting the proportions of the several ingredients contained in any mixture.

Prevalence of Adulteration.

The following particulars will serve to convey some idea of the great prevalence of adulteration.

During the course of the last six years the author has examined minutely and scrupulously, microscopically and chemically, over 3000 samples of the principal articles of consumption, as well as many drugs; and as the one great result of this somewhat extended experience, he affirms that some short time back there were few articles of consumption the adulteration of which was practicable, and which, at the same time, could be rendered profitable, which were not extensively subjected to adulteration.

True it is that adulteration does not now prevail to anything like the extent it did when his investigations first commenced, — this highly important and gratifying result being attributable, in the first instance, to the exposures of adulteration made for so long a period in "The Lancet," and subsequently in the evidence given before the Select Parliamentary Committee on Adulteration.

The evidence of the extensive prevalence of adulteration does not, however, rest upon the testimony, undeniable as that evidence has been shown to be, of a single inquirer; but many scientific observers of undoubted capabilities, and in every respect trustworthy, have testified to the same effect: as in this country, Accum, Mitchell, Normandy, Gray, O'Shaughnessy, Pereira, Thomson, Warington, Taylor, Calvert, Quekett, Bastick, Gay, Phillips of the Excise, and many others; and abroad, MM. Garnier and Harel, and M. Chevallier.

The numerous witnesses examined before the Committee on Adulteration, with one or two unimportant exceptions, concur in their statements respecting the general prevalence of adulteration. Indeed, so conclusive is the evidence deemed, that the Committee state that they have been constrained to acknowledge, as shown in the Preface to this work, that the statements made as to the extensive practice to adulteration have been fully confirmed by the inquiry, and that legislation has been rendered imperative.

Of course no evidence can be more satisfactory or conclusive than that of witnesses who speak to what they themselves have ascertained in the course of their investigations: there is, however, evidence of the existence of adulteration of another kind, and that is the occasional supply of articles of consumption to workhouses and other public establishments *under* market price. We are acquainted with more than one instance of this kind, especially in the articles arrowroot and oatmeal: the difference in price being ascertained to have been made up by adulteration.

Dr. Normandy concludes his evidence before the Parliamentary Committee with this remark: —

"Adulteration is a wide-spread evil, which has invaded every branch of commerce: everything which can be mixed or adulterated or debased in any way is debased." To the general accuracy of this declaration our own experience compels us to subscribe.

It may in the next place be considered *how it happens that adulteration is so prevalent.*

Various reasons have been assigned to account for this prevalence: the majority of these have been suggested by parties more or less interested in adulteration, either directly or indirectly: the principal of them we shall proceed to notice, and first those reasons, or rather excuses, which have been urged in defence of adulteration.

Excuses urged in Extenuation of Adulteration.

One reason assigned in defence of many adulterations is that they are practised in obedience to the wishes and tastes of the public.

Another reason is that the additions made to several articles constitute improvements.

It is on the first of these pleas that the practice of colouring the red sauces, potted meats, and fish with bole armenian; cheese with annatto; pickles, bottled fruits, and vegetables, with copper; and sugar confectionary with various pigments consisting of salts of arsenic, copper, zinc, and antimony, is excused.

Now, although it may be true that the public, in some instances, prefer the more highly coloured article, yet they do so as a mere question of appearance, and in total ignorance of the means by which these colours are obtained: these means explained, and the public made aware of the fact that they are produced by some of the most poisonous substances known, it is not correct to say that they would knowingly sanction the use of these poisons, and would prefer, merely for the sake of colour, articles which were known to contain injurious substances to those which are pure and wholesome.

It is on the second of these pleas, viz., that the additions made to several articles constitute so many improvements, that the addition of chicory to coffee is defended; wheat-flour and turmeric to mustard; sugar and starch to cocoa; sulphuric acid to vinegar. We shall have hereafter to speak of the addition of chicory to coffee, and of sugar and starch to cocoa: we shall show that it is very questionable whether chicory is an improvement to coffee, and whether it is not positively hurtful; if it be an improvement, still it is proper that each of the articles called chicory and coffee should be sold by itself, and used by the public or not as it might wish. In the case of cocoa it will be shown that the sugar and starch are employed in many cases to such an extent that the compound of starch, sugar, and cocoa, scarcely retains the flavour or smell of the latter substance, while its colour is so altered and reduced, that it becomes necessary to have recourse to coloured earths to bring it up to its proper standard.

The manufacturer tells us that mustard by itself is so disagreeable that we could not eat it, and hence the use of wheat-flour and turmeric. But the answer to this statement is, that in some of the so-called mustards, the turmeric and wheat-flour are so out of proportion that the compound scarcely retains the flavour of mustard. Again, that genuine mustard cannot be so unpalateable a thing is shown by the fact that there are now a few manufacturers who profess to sell nothing but the genuine article.

Another plea urged in extenuation of certain additions is, that they are necessary in order to make the articles keep. It was on this ground that the legislature was brought to sanction the addition of sulphuric acid to vinegar; but that it has no real foundation in this case is proved by the fact that there are now manufacturers conducting extensive establishments who do not add even the smallest proportion of sulphuric acid to their vinegar.

When, therefore, the manufacturer or seller defends any particular admixture, or adulteration, on any of the pleas referred to, namely, that it is practised to suit the public taste, that it is an improvement, or that it is necessary in order to make the article keep, we would advise our readers to look well into the matter for themselves; they will be almost sure to find something wrong, some fallacy at the bottom of these statements,—they will too often find that this pretended regard for the wishes and tastes of the public resolves itself into a question of gain to the manufacturer or trader.

Another plea sometimes urged in extenuation of adulteration, and perhaps there is something in it, but not much, is that it is impossible to supply genuine articles at the prices the public is willing to pay for them.

No doubt the public likes to obtain what it requires at as cheap a rate as possible,—but it is for the trader to fix the prices at which he can afford to sell his goods, and not the public: further, if it were explained to the public by the dealer that he could not answer for the quality or purity of the very cheap articles sold, there are, we believe, very few persons who would be so silly as to prefer the adulterated to the genuine article, although the former might be apparently the cheaper.

We say *apparently cheaper*, because in many cases these so-called cheap articles are really the dearest in the end, for, owing to the extent to which they are adulterated, they do not go nearly so far as genuine articles would do. The public, then, we consider is but little at fault: it merely requires to be made acquainted with the true and actual state of things, and there is no doubt but that in ninety-nine out of every hundred cases it would prefer the genuine to the adulterated commodity, even although for this a somewhat higher price had to be paid.

A further excuse sometimes urged in defence of certain adulterations is, that they do no harm. By this plea we suppose is meant, that they are not hurtful to the health, but only to the pocket. On this ground the adulteration of milk with water is sometimes defended: now we are of opinion that there are few more scandalous and indirectly injurious adulterations than this. Milk is an important and prime article of diet, full of nourishment, and in proportion as water is added, so are those who partake of the diluted compound robbed of their proper nourishment.

Such are some of the excuses employed in defence of adulteration. That they should be urged by certain manufacturers and traders, whose profits in some cases are so largely dependent upon adulteration, is not so surprising: but what really is astonishing is, that there should be found some few men, very few we are happy to state, of more or less scientific repute, who, influenced by certain considerations of interest, lend the weight of their names and use their scientific attainments in defence of adulteration.

Science is never so rightly or so nobly employed as when it ministers to the wants and well-being of mankind, and especially when it is used for the protection of the public health. On the other hand, is it not an unworthy and an ignoble use to make of science, to employ it in defence of practices which even those who defend them most in their own consciences must condemn?—and yet there are men who thus demean themselves.

That it would be right to make public the names of those who thus disgrace themselves, to refute their arguments and reasonings, and to expose the motives in which their conduct originates, few will deny: we feel, however, that this is scarcely a fitting place so to do, and shall therefore refrain from pursuing this course: we shall merely refer, in a general way, and as briefly as possible, to the kind of arguments resorted to by the persons to whom we have alluded. Of course they employ the different reasons, or rather pleas, to which we have referred, and the fallacy of most of which we have exposed; but in addition to which they resort to other proceedings.

Thus they endeavour, if possible, to get up a cry of exaggeration, and this in the face of evidence of the most conclusive and demonstrative character.

Another course pursued is to cite some of the less important instances of adulteration, as, for example, the addition of alum to bread, of water to gin, and to argue from them as though they were not, as they really are, parts of a system, but as though they were the worst instances of adulteration, and as though the entire case rested upon them.

Another favourite plea used in extenuation of adulteration is that the quantities in which some of the substances are employed, as those used for the sake of colour, are too inconsiderable to be productive of hurtful results.

This is so sometimes, but it certainly is not the case in the majority of instances: in many cases injurious consequences have been actually proved to ensue; thus many persons have been poisoned outright, and have lost their lives, from the use of coloured sugar confectionary; others have been rendered seriously ill. Cases of lead paralysis have been produced by the lead purposely introduced into snuff, and the same, it has been asserted, has occurred from the use of cayenne coloured or adulterated with red lead. Again, illness of a serious, and even fatal, character has been produced by the use of poisonous adulterants not pigments, as from lead in wine, cocculus indicus in beer and spirits. Indeed, instances might be multiplied to a large extent of disease originating in the use of substances employed for adulteration. Who can tell how many invalids and tender children have fallen victims to the dangerous adulterations practised upon food, drinks and drugs, if the true causes of premature death could be traced out in all such cases? That dyspeptic ailments often owe their origin to the adulteration of articles of food is unquestionable.

Besides, if the employment of poisonous pigments and other substances are to be permitted at all, what guarantee or security have we against accidents resulting from the careless and ignorant use of such poisonous or injurious articles? The only right and safe principle upon which to act we maintain is to discard the use of all additions to articles of consumption that are unnecessary, and which may possibly become a source of danger. Again, it must be remembered that the ill effects of adulteration cannot be estimated by the quantity of any particular ingredient contained in any one article: so prevalent is adulteration, that in the course of a single day it often happens that several injurious ingredients are partaken of, and in order to arrive at any correct conclusion we must therefore take the sum of the whole of these ingredients. See p. 21.

Lastly, in endeavouring to estimate the effects of adulteration on health, the fact must be borne in mind that some of the metallic poisons used are what are called *cumulative*. See p. 20.

We have been induced to enter into an examination of the various pleas on which the practice of adulteration is sometimes defended, in order that when the readers of this work hear them urged, as some of them doubtless will, they may know what they are really worth, and how they may be refuted.

Having noticed the various pleas on which adulteration is defended, we have still to consider to what cause or causes its prevalence is due.

Real Causes of the Prevalence of Adulteration.

The great cause which accounts for the larger part of the adulteration which prevails is the desire of increased profit; a second cause is excessive and unfair competition. A trader, perceiving that his neighbour in the same business is selling his goods at prices at which, if genuine, it would be impossible to realise a profit, knows that this can only be done by having recourse to adulteration, and finding that he cannot compete with his unscrupulous fellow trader, at length he himself too often has recourse to the same practice. We thus perceive how difficult it is for many tradesmen who desire to do so to conduct their businesses in a honourable way, and to resist the temptation to adulterate. The main causes of the prevalence of adulteration are, then, the desire of increased profit and excessive and unfair competition.

Who are the Parties guilty of Adulteration?

The next question for consideration is, who are the parties guilty of adulteration.

The answer is, in some cases, the manufacturers, and in others the retail dealers. This distinction is of the utmost importance, especially with reference to the means to be adopted for the discovery and suppression of adulteration.

Some of the adulterations practised require to be so on the large scale, and involve the use of extensive machinery, which the tradesman does not possess; and in consequence certain adulterations, as of flour, of chicory, of cocoa, of spices, and of many drugs, are practised by the grinders and roasters of those articles: there is a class of persons known as Spice and Drug Grinders, with whom lies much of the fault of the adulteration of spices and drugs.

In the drug trade the practice at one time was very general, and it still prevails to some extent, of adding sawdust of different kinds, as well as other articles, in order, it was urged in excuse, to make up for the varying and average loss sustained by different drugs in the course of drying and grinding to a uniform loss of 4 per cent. This is called the 4 per cent. system; however, the practice does not stop here, but leads to every species and degree of abuse.

The adulterations of mustard, vinegar, annatto, snuff, coloured sugar confectionary, and some other articles, are also usually practised by the manufacturers.

There are good reasons why, in many cases, the manufacturer should be the adulterator; not only has he the necessary machinery and the means of performing the requisite operations on a large scale, but the responsibility of adulteration is thus taken off the shoulders of the tens of thousands of traders by whom the public is immediately supplied, and is confined in some degree to the comparatively small body of manufacturers, whose proceedings are conducted in retirement and secrecy, and whose premises are not accessible to the public.

The retail trader, however, takes in many cases his share in the work of adulteration; as one example, we may mention that much of the adulteration of beer and spirits is perpetrated by the publican. Even in those cases in which the retailer does not himself adulterate, he often purchases of adulterating merchants with guilty knowledge; thus, in many cases, he is aware of the fact that the article he purchases is adulterated, from the price paid for it being less than that at which the genuine article can be procured. In such cases the tradesman is a party to the fraud, and is as guilty as the actual perpetrator of the adulteration.

It should be known that even the purchasing of articles of consumption in the raw state by the trader affords no guarantee for the genuineness of those articles, provided they are afterwards sent to the grinder or manufacturer to be ground or manufactured. We have known tradesmen who, wishing to protect themselves as far as possible against adulteration, have purchased the best cocoa beans and chicory nibs, and have then sent them to the grinder to be prepared, but, upon being returned to them, they were found to be adulterated. Messrs. Ridgway and Co., of King William Street, forwarded to the author, some time since, some flake cocoa for examination: this was found to be adulterated with wheat-flour. Messrs. Ridgway then stated that they purchased the best cocoa beans they could procure, and sent them to the manufacturer to be made into *flake* cocoa, which should consist of nothing but cocoa. The manufacturer, in this case, had subtracted some of the cocoa, and had replaced it with wheat-flour. Since this occurred Messrs. Ridgway have had a mill erected on their premises, and now make their own flake cocoa.

Now it must not be inferred from these remarks, that there are not many honest manufacturers and traders connected with the manufacture and sale of articles of consumption. We know that there are many such, and on behalf of some of those who either are really guilty of, or who lend themselves to adulteration, the excuses may be urged that until very recently the legislature has been indifferent to this subject, that it does not protect the honest trader, and that in self-defence, and for very livelihood's sake, he is often driven to adulterate.

CLASSIFICATION OF ADULTERATION.

Not only is adulteration prevalent, but *the substances employed are very numerous*; different kinds of substances being used for different purposes. The majority of substances used are so for one of three purposes: either for the sake of *bulk* or *weight*, the articles used of course being cheaper than those to which they are added; for the sake of *colour*, that is, to heighten and improve the appearance of articles as it is considered, often erroneously, the natural colour of such articles being frequently altered and reduced by dilution with other adulterating substances added for bulk and weight; or, lastly, to increase the *pungency* of articles, and to heighten their *properties* and *flavour*.

The first kind of adulteration is the more usual form, and is that by which the practice is rendered so profitable; the second, that which consists in the addition of colouring matters of various kinds, is often necessitated by the first kind, so that these two descriptions of adulteration frequently go together.

An example of the first kind of adulteration is furnished by the addition of roasted corn to chicory or coffee powders, and of water to milk.

Of the second, in the addition of red lead to cayenne, Venetian red, umber, &c., to chicory and cocoa; while an example of the third form of adulteration is met with in the addition of alkalies, as also the chromates of potash, hellebore, and powdered glass to snuff.

Now it is in the second class, viz., that which consists in the employment of colouring matters of various kinds, that the majority of those adulterations are included which are prejudicial to health: this will be seen more clearly hereafter.

So numerous and various are the substances employed for adulteration that a classification of them according to the articles in which they are encountered, and the purposes to which they are applied, becomes useful. Such a classification is given in the following tables.

The annexed Table contains only the names of those substances which we have ourselves ascertained, by original observations and analyses, to be actually employed for the adulteration of Articles of Food; it does not include Drugs.

Classified List of the various Substances ascertained by Ourselves to be employed for the different Purposes of Adulteration: viz. for Bulk and Weight, for Colour, and for Smell, Taste, and other Properties.

	For Bulk and Weight.	For Colour.	For Taste, Smell, and other Properties.
ANNATTO.	Rye, Wheat and Barley Flours, Turmeric, Carbonate and Sulphate of Lime, Red ferruginous Earths, Red Lead, Salt.	Turmeric, Red ferruginous Earths, Salt, Alkali.	Sulphate of Copper.

	For Bulk and Weight.	For Colour.	For Taste, Smell, and other Properties.
Arrow-Root -	Sago, Potato, and Tapioca Starches, and various mixtures and combinations of these with the inferior arrow-roots.		
Anchovies -	Dutch, French, and Sicilian Fish.	Bole Armenian, Venetian Red.	
Brandy - -	Water - - - -	- - - -	Burnt Sugar.
Bread -	Mashed Potatoes, Rice, Beans, Rye, Indian Corn	- - - -	Alum, Hards and Stuff.
Butter - -	Water.		
Bottled Fruits and Vegetables.	- - - -	Salts of Copper, usually the Acetate or Sulphate.	Salt.
Cheese - -	- - - -	Annatto, Bole Armenian, Venetian Red.	
Cinnamon -	Cassia, and most of the articles mentioned under Spices.		
Coloured Confectionary.	East India Arrow-root, Wheat and Potato Flour, Hydrated Sulphate of Lime.	Cochineal, Lake, Indigo, Prussian Blue, Antwerp Blue, Artificial Ultramarine, Carbonate of Copper or Verditer, Carbonate of Lead or White Lead, Red Lead, Vermilion; Chrome Yellow or Chromates of Lead, Lemon, Orange and deep; Gamboge; Sap Green; the three Brunswick Greens, Emerald Green or Arsenite of Copper, Indian Red; brown ferruginous earths, chiefly Umber, Sienna, and Vandyke Brown, and various combinations of the above pigments.	
Coffee -	Chicory, Roasted Wheat, Rye and Potato Flours, Roasted Beans, Mangel-wurzel, Acorns.	Burnt Sugar, or Black Jack.	
Chicory -	Roasted Wheat and Rye Flours, Burnt Beans and Acorns, Sawdust, Mahogany Sawdust, Carrot Mangel-wurzel.	Ferruginous earths, as Venetian Red and Umber, Burnt Sugar or Black Jack.	
Cocoa and Chocolate.	Maranta, East India, and Tacca or Tahiti Arrow-roots; Tous les Mois; the Flours of Wheat, Indian Corn, Sago, Potato, and Tapioca, and various Mixtures of these; Sugar, Chicory, Cocoa Husks.	Venetian Red, Red Ochre, and other ferruginous earths.	
Cayenne Pepper - -	Ground Rice, Mustard Husk, Salt.	Red Lead, Vermilion or Bisulphuret of Mercury, Venetian Red, Turmeric.	

	For Bulk and Weight.	For Colour.	For Taste, Smell, and other Properties.
Custard and Egg Powders	Wheat, Potato, and Rice Flours.	Chrome Yellow or Chromate of Lead, Turmeric.	
Curry Powder	Ground Rice, Potato-farina, Salt.	Red lead	Salt.
Flour	Rice, Beans, Rye, Indian-Corn, Potato Flour.	- - - -	Alum.
Ginger	Wheat, Sago, and Potato Flours, Ground Rice, Mustard Husks.	Turmeric Powder.	
Gin	Water, Sugar	- - - -	Cayenne, Cassia or Cinnamon, Sugar, and flavouring of different kinds. For fining, Alum, Salt of Tartar.
Honey	Flour, Cane Sugar.		
Isinglass	Gelatine.		
Lard	Potato-flour, Water	- - - -	Salt, Carbonate of Soda, Caustic Lime.
Liquorice	Wheat-flour, Potato Starch, boiled Starch probably Rice, Chalk, and Gelatine.		
Mustard	Wheat-flour, Turmeric	Turmeric.	
Milk	Water	Annatto.	
Marmalade	Pulp of Apple or Turnip.		
Oatmeal	Barley-flour, and the integuments of Barley called Rubble.		
Porter and Stout.	Water	Sugar, Treacle.	Sugar, Treacle, Salt.
Pickles	- - - -	Salts of Copper, usually the Acetate of Copper.	
Potted Meats and Fish.	Flour, probably Wheat-flour boiled.	Bole Armenian, and sometimes Venetian Red.	
Preserves	Salts of Copper, including the Acetate.		
Pepper	Wheat and Pea Flour, Ground Rice, Ground Mustard Seeds, Linseed Meal, P. D., or Pepper-Dust.		
Sago	Potato-flour.		
Snuff	- - - -	The Chromates of Potash, Chromate of Lead, ferruginous earths, chiefly Umbers, Red and Yellow Ochre, Red Lead, or Oxide of Lead.	The Chromates of Potash, Carbonate of Ammonia, Lime, Powdered Glass or Silex, Powdered Orris-root.
Rum	Water	- - - -	Cayenne, Burnt Sugar.
Sugar	Wheat-flour in two cases only, Potato-flour, and Tapioca-starch, each in one sample.		
Spices:			
Cloves	Powdered Clove-stalks in one case.		
Cinnamon	Cassia, Wheat-flour, Sago-meal, and mixtures of these; East India Arrow-root, Potato-flour.		

	For Bulk and Weight.	For Colour.	For Taste, Smell, and other Properties.
PIMENTO -	Mustard Husk in one instance.		
MIXED SPICE	Wheat, Sago, and Potato-Flours, Ground Rice, two Vegetable Substances, one of which resembled Linseed.		
SAUCES, as the Essences of Anchovies, Lobsters, and Shrimps, and Tomato Sauce.	- - - -	Red ferruginous earths, as Bole Armenian and Venetian Red.	
TEA - - -	Exhausted Tea Leaves; Leaves, other than those of Tea, British and Foreign, amongst the former those of Sycamore, Horse-chesnut, and Plum; Lie Tea, Paddy Husk, Sand, Starch.	Plumbago or Black Lead, Gum, Indigo, Prussian Blue, Turmeric, Chinese Yellow, China Clay, Soap-stone or French Chalk	Sulphate of Iron, Catechu, Gum, La Veno Beno, Chinese Botanical Powder.
TOBACCO - -	Water, Sugar, Treacle, Salts, Oil.		
VINEGAR - -	Water - - -	Burnt Sugar - -	Sulphuric Acid.

Of the three following Tables, the first is of articles ascertained to be used by others; the second, of articles stated to be employed by different writers, but of the use of which no positive proof is given, although there is no doubt but that most of them either have been, or are occasionally employed, and the third is a list of articles the use of which appears to be but little probable, although stated to be sometimes had recourse to for the purpose of adulteration.

List of Articles ascertained by Others to be used for the Purpose of Adulteration.

	For Bulk and Weight.	For Colour.	For Taste, Smell, and other Properties.
BREAD - -	Sulphate of Copper.		
FLOUR - -	Mineral White or Hydrated Sulphate of Lime.		
GIN - - -	- - - - -	- - - - -	Grains of Paradise, Sulphuric Acid, Various Gin Flavourings, containing Coriander Seeds, Angelica Root, Oil of Almonds,

	For Bulk and Weight.	For Colour.	For Taste, Smell, and other Properties.
			Calamus Root, Almond Cake, Orris Root, Cardamom Seeds, Orange Peel, Grey and White Salts.
Lard - -	Mutton Suet - - -	Alum, Potash.	
Milk and Cream.	Flour or Starch, Treacle.		
Pepper - -	Woody Fibre.		
Porter and Ale	- - - - - -	- - - - -	Cocculus Indicus, Grains of Paradise, Capsicum, Ginger, Quassia, Wormwood, Calamus Root. Caraway and Coriander Seeds, Ginger, Orange Powder, Liquorice, Honey, Sulphate of Iron, Sulphuric Acid, Cream of Tartar, Alum, Carbonate of Potash, Oyster Shells, Hartshorn Shavings, Fabia amara or Nux Vomica, Beans.
Rum - - -	- - - - - -	- - - -	Cocculus Indicus.
Snuff -	Quassia, Gentian and Colombo Root, Peat, Moss, Earthy Matter, Rhubarb Leaves, Leaves of Trees, Fustic Wood, Woody Fibre. Hellebore		
Tea - - -	The leaves of Beech, Plane, Bastard Plane, Elm, Poplar, Willow, Fancy Oak, Hawthorn, Sloe.	Rose Pink, Dutch Pink, Vegetable Red and Yellow Dyes, Chrome Yellow, Venetian Red, Carbonate of Copper, Arsenite of Copper, Chromate and Bichromate of Potash, Carbonates of Lime and Magnesia.	
Tobacco - -	Rhubarb, Potato, Coltsfoot, Dock, and other British Leaves, Sawdust, Malt Comings, Earthy Matter, Sand.	- - - - -	Nitrate of Soda.
Wine - -	Water, Brandy, Corn Spirit, Jerupiza, Cider, mixtures of inferior and different wines.	Elder-berry juice, Logwood, Brazil wood, Bilberries, Burnt Sugar.	Lead, Bitartrate of Potash, Oak Sawdust, Catechu, Cherry Laurel Water.

List of Articles stated by Others to be employed for the different Purposes of Adulteration, but of the Use of which no Positive Evidence has been adduced, although it is extremely probable that many of them have been, or are occasionally, had recourse to.

	For Bulk and Weight.	For Colour.	For Taste, Smell, and other Properties.
ARROW-ROOT -	Ground Rice.		
ANCHOVIES -	Sprats.		
BREAD - -	Barley, Oat, Pea Flour, Pipe Clay, Plaster of Paris, Bonedust.		
COLOURED CONFECTIONARY.	White Potter's clay, Pipe Clay. or Cornish Clay; Chalk, Plaster of Paris, Sand.	Cobalt, Smalt, Ultramarine, Litmus, Naples Yellow.	
COFFEE - -	Roasted Peas, Coffee Grounds, Parsnip.	Madder Root.	
CHICORY - -	Torrefied Ground Rice. Roasted Biscuit, Oak Bark Tan, Exhausted Tan, called Croats.	Baked Horse's Liver, Burnt Blood.	
COCOA AND CHOCOLATE.	Old Sea Biscuits, Coarse Branny Flour, Animal Fats, as Tallow, Lard, Treacle, Sulphate of Lime, Chalk.	Red Lead, Vermilion, Red and Yellow Ochre.	
FLOUR - -	Chalk, Bone Earth, Plaster of Paris, Powdered Flints.		
GIN - - -	- - - - - -	- - - - - -	Acetate of Lead. Oil of Turpentine.
LITMUS - -	- - - - - -	- - - - -	Common Arsenic and Peroxide of Mercury.
MUSTARD - -	Pea-flour, Linseed-meal, Radish Seeds.		
MILK - -	Sheep's Brains, Chalk.		
PEPPER - -	Ground Oil Cake, Clay.		
RASPBERRY JELLY	Currant Jelly - - -	- - - - -	Orris-root.
SUGAR -	Sand, Plaster of Paris.		
SAUCES - -	Chalk, Plaster of Paris.	Red Lead.	
TOBACCO - -	The leaves of Cabbage, Seaweed, Roasted Chicory-root, Bran, Oakum.	Liquorice, Beet-root Dregs, Catechu, Fuller's Earth.	Sal Ammoniac, Carbonate of Ammonia, Nitrate of Ammonia, Salt, Alkalies, as Potash and Soda; Catechu or Terra Japonica, Opium.
VINEGAR - -	- - - - - -	- - - - -	Acetic, Pyroligneous, Hydrochloric, Nitric, and Tartaric, Acids; Cayenne, Long Pepper, Mustard Seed, Salt.

List of Articles stated to be used, but scarcely likely to be employed, for the Purpose of Adulteration.

	For Bulk and Weight.	For Colour.
ANCHOVIES	Plaster of Paris.	
BUTTER	Lard.	
COFFEE	Madder-root	Madder-root.
CHICORY	Brick-dust	Brick-dust.
CAYENNE	Brick-dust	Brick-dust.
MILK	Milk of Almonds, Gum, Gum Tragacanth.	
PORTER AND ALE	Opium.	
VINEGAR	Oxalic Acid.	

Another arrangement or classification of substances used for adulteration is into those that are not injurious, but the use of which is simply fraudulent, and into those which are hurtful to health. A list of all the substances employed for adulteration, which are more or less prejudicial to health, will be given hereafter.

IMPORTANCE OF THE SUBJECT OF ADULTERATION.

The subject of adulteration is undoubtedly one of high importance, and in its consequences it affords much material which may fairly engage the earnest thoughts of the financier, the sanitarian, and the moralist.

The financier, because it involves to a large extent considerations of profit and loss; profit to the manufacturer and seller of adulterated articles, and loss to the consumer and the revenue.

The sanitarian, because some of the articles employed in adulteration are of an exceedingly injurious character, and calculated to affect materially the public health.

And the moralist, since the practice of adulteration involves deception, and even fraud.

Adulteration is therefore a great national question, closely affecting the pocket of the consumer, the revenue, and the health and morals of the people. We shall now proceed to enlarge upon each of these heads.

The pecuniary Bearings of Adulteration.

The pecuniary bearings of the subject of adulteration are of very great importance, and they relate to the consumer, the manufacturer, merchant, or tradesman, and the revenue.

The great profit of adulteration arises from the sale of articles so adulterated as to be greatly inferior in value to genuine commodities, a price being demanded for these mixed goods yielding a larger profit than could be obtained by the sale of unadulterated goods; in fact, they are often sold at the rate of the pure articles. This increased profit to the seller is just so much loss to the consumer. This may be illustrated by the sale of mixed chicory and coffee as genuine coffee: chicory may be purchased for about 30*s.* the cwt., or about 3*d.* per lb.; coffee for 80*s.*, or nearly 9*d.* per lb. Now coffee, as frequently sold, often contains 50 per cent., and in many cases much more than this, of chicory; and for the mixture, half chicory and half coffee, worth about 6*d.* or 7*d.* per lb., from 1*s.* to 1*s.* 6*d.* is charged.

So great is the loss of the consumer arising out of the practice of adulteration that it is questionable whether it does not amount in most cases to more than the sum of the whole of his taxes. The greatest losers by adulteration are the humbler classes, the labourer and the artisan, who are compelled to purchase the articles they use at the cheapest shops, where adulteration prevails to the greatest extent. This practice therefore presses with peculiar hardship upon the labouring portion of the population.

It is clear that the sellers of adulterated articles of consumption, be they manufacturers or retail dealers, are in a position to enhance their profits by the practice of adulteration, and are enabled to undersell, and too often to ruin, their more scrupulous and honest competitors.

The question of the adulteration of food is therefore one which vitally affects the interests of *the more honest and respectable portion of the trading community*, who depend upon the manufacture and sale of articles of consumption, and it behoves them strenuously to exert themselves to put an end to the prevailing system of adulteration which is undermining the very foundation of trade, namely, FAITH IN COMMERCIAL INTEGRITY.

The pecuniary interests of the State in the question of adulteration will become apparent when we remember that a large part of the revenue is derived from duties on articles of consumption. The more these articles are adulterated, the more is the revenue defrauded.

It is not possible to estimate with any degree of certainty the precise loss to the State arising out of adulteration; but it is evident from the millions of money derived from duties on articles of consumption, and from the extent to which adulteration has prevailed and still prevails, that the loss must amount annually to many hundreds of thousands of pounds. A calculation has been made, whereby the loss to the revenue from adulteration is estimated at two millions annually. The author of the "Food of London,"* p. 138., states that half the national revenue is derived from articles of consumption. These few facts are sufficient to show the paramount importance of adulteration to the national Exchequer.

If the State loses so much, it is pretty certain that the public suffers a much greater loss.

The Sanitary Bearings of Adulteration.

We now come to consider the question of adulteration *as it affects the public health.* No doubt can possibly be entertained on this subject: no one who examines with sufficient care the facts, but must acknowledge that the subject of adulteration is of the highest importance in a sanitary point of view, and as a question of public health.

In the first place, the adulteration of articles with substances, although harmless in themselves, is frequently prejudicial, by reducing and weakening the natural properties of those articles. This is the case when roasted corn or carrot is added to coffee, and water to milk: but the remark applies especially to medicines; for in this case to reduce the strength of a medicine by adulteration is to destroy or modify the proper action of that medicine. The proper doses of different remedial agents have been determined, in most cases, by careful observation and experiment; and in different doses the same medicine is known to produce very different effects. To adulterate medicines, even with harmless substances, is to destroy the very foundation of the healing art, and so to render nugatory the wisest and best directed efforts of the physician.

In the second place, adulteration acts prejudicially to the public health when substances are employed possessing injurious properties. Now a great variety of such substances are used for the purpose of adulteration. We have ourselves detected, amongst others, the following: — the three chromates of lead, the three Brunswick greens, which are mixtures of the chromates of lead and indigo or Prussian blue, red oxide of lead or red lead, arsenite of copper, sulphate of copper, carbonate of copper or verditer, carbonate of lead or white lead, bisulphuret of mercury cinnabar or vermilion, acetate of copper, sulphate of iron, gamboge, cayenne in spirits, bronze powders, which are alloys of copper and zinc, sulphate of lime, carbonate of lime, red ferruginous earths, and other substances more or less injurious. This list, it will be observed, contains the names of some of the most virulent poisons. Sometimes the quantities of these substances used is so considerable that immediate ill effects are produced: thus, as has already been stated, not a year passes but that serious, and even fatal, accidents arise out of the practice so recklessly pursued of colouring sugar confectionary with poisonous pigments. More frequently the effects are more slowly developed: the substances, although taken perhaps in but minute quantity, gradually and insidiously deteriorate the health, giving rise frequently, amongst other maladies, to various forms of dyspepsia or indigestion: sometimes, as in the case of lead, copper, mercury, and arsenic, they accumulate in the system until at length serious consequences are produced; thus cases of paralysis have been recently traced in the clearest manner to the use of snuff adulterated with preparations of lead; some of these cases will be found recorded in "Food and its Adulterations:" other cases of lead paralysis, it has been stated, have been produced by the use of cayenne adulterated with red lead.

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* By George Dodd. Longman & Co.

The subjoined Table contains not only the names of the substances used in adulteration possessing more or less injurious properties, but also the names of the articles in which they have been discovered: it will be perceived that the number of injurious substances thus employed is very great.

Injurious Substances actually detected in adulterated Articles of Consumption.

Substances.	*Articles.*
Cocculus indicus.	Beer, rum.
Arsenite of copper, emerald green, or Scheele's green.	Coloured sugar confectionary.
Sulphate of copper or blue vitriol, and acetate of copper or verdigris.	Pickles; bottled fruits and vegetables; preserves; dried and crystallised fruits.

Substances.	*Articles.*
Carbonate of copper or verditer.	Coloured sugar confectionary and tea.
The three chromates of lead.	Custard powders, sugar confectionary, tea, and snuff.
Red oxide of lead.	Cayenne, curry powder.
Red ferruginous earths, as Venetian red, bole Armenian, red and yellow ochres, umber, &c.	Red sauces, as shrimp, lobster, anchovy and tomata sauces; and in potted meats and fish, cocoa, chicory, anchovies, annatto, cheese, tea, and snuff, &c.
Carbonate of lead.	Sugar confectionary.
Plumbago or black lead.	In certain black and Lie teas.
Bisulphuret of mercury or cinnabar.	Cayenne, sugar confectionary.
Sulphate of iron.	Re-dried tea, and in beer.
Sulphate of copper.	Bread, rarely; annatto.
Cayenne.	Gin, rum, ginger, mustard.
Gamboge.	Sugar confectionary.
Chromates of potash.	Tea and snuff.
The three false Brunswick greens being mixtures of the chromates of lead and indigo, or Prussian blue.	Sugar confectionary.
Oxychlorides of copper or true Brunswick greens.	Ditto.
Orpiment or sulphuret of arsenicum.	Ditto.
Ferrocyanide of iron or Prussian blue.	Ditto.
Antwerp blue or Prussian blue and chalk.	Ditto.
Indigo.	Ditto.
Ultramarine.	Ditto.
Artificial ditto.	Ditto.
Hydrated sulphate of lime, mineral white, or plaster of Paris.	Flour, bread, sugar confectionary.
Alum.	Bread and flour.
Sulphuric acid.	Vinegar, gin.
Bronze powders or alloys of copper and zinc.	Sugar confectionary.

Now with evidence such as the above, it is impossible to contend that the use of such a variety of injurious, and even poisonous, substances is unattended with danger, and that adulteration does not affect the public health. It may so happen, and it doubtless does sometimes occur, that the same person, in the course of a single day, receives into his stomach some eight or ten of the articles above enumerated. Thus, with the potted meats and fish, anchovies, red sauces, or cayenne, taken at breakfast, he would consume more or less bole Armenian, Venetian red, red lead, or even bisulphuret of mercury. At dinner, with his curry or cayenne, he would run the chances of a second dose of lead or mercury; with the pickles, bottled fruits and vegetables, he would be nearly sure to have copper administered to him; while if he partook of *bon bons* at dessert, there is no telling what number of poisonous pigments he might consume. Again, in his tea, of mixed or green, he would certainly not escape without the administration of a little Prussian blue, and it might be worse things: if he were a snuff-taker, he would be pretty sure to be putting up his nostrils, from time to time, small quantities of either some ferruginous earth, bichromate of potash, chromate of lead, or red lead: finally, if he indulged himself with a glass or so of grog before going to bed, he would incur the risk of having the coats of his stomach burned and irritated with tincture of capsicum or essence of cayenne. If an invalid, his condition would be still worse; for then, in all probability, he would be deprived of much of the benefit of the skill of his physician through the dilution and sophistication to which the remedies administered for his relief were subjected. This is no fanciful or exaggerated picture, but one based upon the results derived from the repeated analysis of different articles as furnished to the consumer.

Moral Bearings of Adulteration.

The third and last aspect in which adulteration is to be considered is the moral.

It is impossible for a man to be guilty of adulteration and yet be an honest and a moral man. Can it even be said of the adulterator, be he a manufacturer or a roaster and grinder of chicory and coffee, or be he a retail tradesman who sophisticates the goods which he sells and mixes them with roasted corn or beans, Venetian red, &c., that he is guilty of a less offence than the common thief? The last takes but our property, while the former not only robs us of our substance but sometimes destroys our health as well.

But adulteration not only makes those who practise it dishonest, but other very serious evils often ensue: thus it begets a loss of confidence on the part of the buyer in those with whom he deals. In this way sometimes not only does the honest trader come to be looked upon with the same suspicion as the adulterating merchant or tradesman, but the *status* of the whole of that portion of the trading community engaged in the sale of articles of consumption is lowered, and it is looked upon with misgiving in all its transactions; lastly, the character of the whole nation for integrity in its dealings suffers in consequence of adulteration.

There is, then, scarcely an individual whose interests are not deeply concerned in the subject of adulteration. The interests of large public institutions of all kinds are vitally affected by adulteration, as our hospitals and other charitable establishments, workhouses, barracks, shipping, lunatic asylums, public schools, and similar institutions. Many of these establishments are supplied by contract with different articles of consumption, as tea, sugar, coffee, cocoa, arrowroot, oatmeal, spices, &c. Now it often happens that the articles, and especially oatmeal and arrowroot, supplied under these contracts, are adulterated, and this is frequently to be explained by the fact that these and other articles are sometimes purchased *under* market price, and consequently cannot possibly be genuine.

Taking into consideration, therefore, all the circumstances of the case, we believe it to be almost impossible to over-estimate the importance of the subject of adulteration, viewed either as a question of public health, of pecuniary loss to the consumer and the revenue, or as one of morality. To sum up, it is not too much to say that the question of adulteration is one which affects the health of thousands, and even the lives of many; that hundreds of thousands of pounds are annually lost to the consumer and the revenue by the practice of adulteration; and that by its prevalence the moral *status* of the commercial portion of the community of this country is lowered in the eyes of the world.

THE REMEDIES FOR ADULTERATION.

The means to be employed for the suppression of adulteration are of two kinds, viz., those which are required for the *discovery* of adulteration, and those for its *punishment*.

The principal means to be adopted for the detection of adulteration are, First,—The appointment in the principal towns and districts of the United Kingdom of inspectors and analysts. The duty of the inspectors would be, to procure articles of food and medicine, to forward them to the analyst of his district for his analysis and report, and to bring cases of adulteration before the proper authorities for adjudication. In our import towns a principal additional duty of the inspector would be, to watch over articles of food and medicine brought to this country, and, in doubtful cases, to forward them to the analyst for his opinion. Lastly, the inspector, like the present Excise officers, should, in certain cases, have the power of entry on suspected premises; in general, however, the samples collected for analysis should be procured, in the presence of a witness, in the ordinary way, by purchase, and the power of entry would rarely require to be enforced. The Excise obtains its evidence of adulteration chiefly by the seizure of articles in the warehouses, &c., forcibly entered, of the adulterator; in this respect a very great difference would exist between the proceedings of the Excise and that of the authorities now proposed to be called into operation.

While it would be requisite that every chief town and district should be provided with its inspector, it would not be necessary to appoint an equal number of analysts, as the same analyst could, in many cases, act for several towns. In the appointment of analysts, special regard should be had to their qualifications, and none should be appointed who were not conversant with the application of the microscope to the detection of adulteration.

The appointment of the inspectors and analysts to be vested in the municipal or other local authorities.

Second,—That a Metropolitan Board of Inspectors and Analysts be appointed, its appointment to be in the hands of the Government. To this board should be confided the charge of dealing with the subject of the adulteration of the food and medicine of the metropolis and its suburbs. The board should publish periodical reports of its proceedings, these reports containing the particulars of the articles analysed, including the names and addresses of the parties of whom they were procured, and this whether they proved to be genuine or adulterated. Further, the local inspectors and analysts should be required to make periodical returns of their proceedings to the

Metropolitan Board. By this means a vast amount of useful information in regard to adulteration would be accumulated, and the several local authorities would be kept up to the full measure of their duties. Lastly, in the Central Board the local analysts would possess an authority on adulteration of the highest character, which they might consult at all times in cases of doubt and difficulty. We consider the institution of this Board absolutely indispensable to the successful working of any scheme designed for the repression of adulteration. Without it, although local inspectors and analysts might be appointed, but little good would be effected, because there would be no sufficient authority over them to ascertain whether they discharged their duties properly and efficiently.

Further, the services of the different Boards of Health, the various sanitary officers, and inspectors of nuisances, might be made available to some extent in procuring articles of food and medicine suspected to be adulterated.

For the prevention and punishment of adulteration, the following are the measures which appear requisite.

That all cases of adulteration should be disposed of summarily before the Justices of the Peace, but with a right of appeal to the Court of Quarter Sessions.

That a system of publication of the names and addresses of all persons whose goods have been analysed should be adopted, and this whether the articles on examination proved to be adulterated or genuine.

That the sellers of adulterated articles should be punished by the infliction of fines, and the actual adulterator by fine or imprisonment, especially in the case of second offences.

That it should be rendered imperative on persons convicted of selling adulterated articles that they should keep a placard containing the text of the judgment condemning them posted up in the most prominent part of their windows for three, six, nine, or twelve months at a time.

Few methods of punishing fraudulent tradesmen could be devised more effectual than this, and which, we have been given to understand, has been enforced in France.

The above is a short outline of the chief measures which appear to be necessary for the discovery and prevention of adulteration. The punishments proposed should extend to all kinds of adulteration, whether injurious to health, involving pecuniary loss, or whether simply deceptive; in fact, the definition of adulteration already given, and which may here be repeated, should be adhered to.

"Adulteration consists in the intentional addition to an article, for purposes of gain or deception, of any substance or substances the presence of which is not acknowledged in the name under which the article is sold."

According to this definition, the sale of *mixed articles* under the name of one only of the ingredients entering into the composition of the mixture would be punishable. We regret exceedingly to find that the Parliamentary Committee on Adulteration propose to attach punishments to certain adulterations only, — those involving pecuniary loss to the purchaser, or which are injurious, either directly or indirectly, to health.

It is not proposed to affix any punishment to adulterations with substances of a cheap and innocuous character; provided "the public derive the full benefit of this cheapness in a lower price." It is not even recommended that such mixed articles should be sold as mixtures, the label affixed to them specifying the composition of the mixture.

That is to say, supposing the recommendations of the Committee to be acted upon, it will still be lawful to sell a variety of mixed articles, as tea, coffee, chicory, arrowroot, &c., which are not what, by the name under which they are sold, they profess to be, and what assuredly they ought to be. Thus for a very large proportion of the adulterations actually practised, not only would no remedy be provided, but a positive legal licence would be given for their perpetration.

The Committee acknowlege that "the public morality is tainted, and the high commercial character of this country seriously lowered, both at home and in the eyes of foreign countries," through adulteration. We very much fear that the recommendation of the Committee respecting "innocuous" adulterations is by no means calculated to take away this national reproach.

Besides, this distinction of adulteration into harmless and hurtful opens the door to perpetual conflicts of opinion and litigation as to what constitute innocuous and what injurious adulterations; whereas there is no commercial adulteration which can be practised that is not injurious in some sense or other, either to public morality, to the pocket, or to health.

To make such a distinction as this is to leave untouched the dishonesty necessarily involved in the practice of adulteration of every kind. According to our views, all adulteration is to be condemned, because it involves at least intentional and designed deception; but the Committee would indirectly sanction, and almost legalise, a large class of deceptive adulterations, and thus, in some respects, matters would be rendered worse than they even are at present. There are few persons who do not feel that in practising adulteration of any kind they are guilty of that which is wrong, and which they would be ashamed to avow openly; but the Committee would take away this sense of shame, and tell us that many adulterations are not reprehensible, and ought to be connived at by the Legislature.

It is true the Committee throw in a kind of saving clause, and state, "provided the public derive the full benefit of this cheapness in a lower price." It is well known that most articles are sold in the mixed state chiefly to enhance profits, and that almost constantly the public are losers by such mixtures; but the great difficulty will be to produce satisfactory proof of the pecuniary loss sustained. In many cases it is not possible to determine the proportions of the several ingredients in a mixture, and these being undetermined, it is impossible to ascertain the value of the mixture.

We are decidedly of opinion, therefore, that under the head of "innocuous" adulterations, the public would be defrauded to an enormous extent.

A single good purpose served by this distinction of adulteration into innocuous and hurtful we cannot perceive. It appears to us that no real difficulty exists either in defining what constitutes adulteration, or in determining how to deal with it. The course dictated by common sense should be followed—viz., that of requiring that every article should be what it professes to be, and what the public understand it to be by the name under which it is sold. On this point, therefore, we consider that the Committee have fallen into a grave mistake.

We much regret that the Committee should have involved themselves in this difficulty, seeing that the right course to pursue is so plain and obvious,—namely, to require that every article should be what it professes to be by the name under which it is vended. If it be sold as mustard, arrowroot, or cocoa, it should be one or the other of those articles, and nothing else.

If it be right to allow the sale of mixed articles, it is doubtless only commonly honest and just that these articles should be sold as mixtures, and their composition specified.

In adopting this course, no real difficulty whatever exists, as it would be easy to devise names sufficiently appropriate by which these mixtures might be distinguished, as — "mixed mustard, consisting of mustard, wheat-flour, and turmeric;" "mixed cocoa, consisting of cocoa, sago, and sugar."

But we would go further than this, and require that the proportions of the several ingredients should be specified thus: "*Mixed Mustard*, containing mustard 50, wheat-flour 40, and turmeric 10 parts; and the same with coffee and some other mixtures. Now the labelling of articles in this way has already been sanctioned by the legislature, which requires that mixed coffee and chicory should be sold only as thus labelled: "This is sold as a mixture of chicory and coffee." All that is needed, therefore, is an extension of the same system.

With regard to the punishments for adulteration, we perceive that the only punishment which the Committee recommend to be inflicted is that by fine.

The Report of the Committee states: "A summons shall be issued, and the case be investigated before the justices, who shall have power to inflict summary punishment, by fine or imprisonment, in every case where pecuniary fraud or danger to health shall have been proved."

We fear that it must be concluded, from the wording of the above paragraph, that the punishment of imprisonment is only proposed to be inflicted in default of payment of the fine. If this be so, then our conviction is, that pecuniary fines are a most inadequate punishment; they neither are adequate to the serious nature of the offence committed, nor will they serve to check adulteration to any extent. The system of fines has been repeatedly tried, and has hitherto failed. Of what moment is a fine of a few pounds to an adulterating merchant, spice or drug grinder, who, probably, before the discovery of his guilt, has been engaged for years in adulteration, whereby he has realised hundreds and thousands of pounds? Besides, to adulterate is to commit fraud, and surely it cannot be right to compound with fraud by a money payment. What is required is, that adulteration should be branded as a crime, and this can only be done by affixing to it some punishment which shall entail personal discredit and disgrace, such as that of imprisonment. We are therefore decidedly of opinion that imprisonment ought to form one of the punishments for adulteration, it being reserved for the worst cases, and for second offences. The punishment by fines only will effect little or nothing for the suppression of adulteration. On referring to the laws in force against adulteration in France, Belgium, Prussia, Holland, Hamburgh, and even New York, we find that imprisonment is one of the punishments enforced against adulteration. Why then, we ask, are adulterators in England — a country formerly presumed to set a pattern of commercial integrity to the world — to be dealt with so gently? The Committee, who have taken great pains to collect the laws in force in other countries, could, we should suppose, scarcely have failed to notice the efficient character of those laws, as contrasted with their own feeble recommendations. Amongst other penalties inflicted in most countries, are the confiscation of the adulterated goods, and the prohibition of confirmed adulterators from following their trades or callings. The Report of the Committee is silent on both these points.

The parties whom the Committee recommend to be punished are *the actual adulterator and, with certain restrictions, the seller.* It is not proposed that the seller should be held responsible when "he can afford satisfactory proof that he has himself been deceived, and was not conscious of the adulteration practised, unless he has evinced a culpable knowledge of the trade which he professes to follow."

In legislating upon the subject of adulteration, it should be remembered that the seller is frequently as much a party to adulteration as the actual adulterator. This is shown by the fact that he often buys articles at prices at which he knows it is impossible that they can be genuine. Again, it should be recollected that it is often the interest of the seller to screen the adulterating wholesale merchant or manufacturer, he, in many cases, being largely in his debt. In the course of the publication of the reports of "The Lancet" Sanitary Commission we met with many cases in which the seller preferred to incur the risk consequent upon the publication of his name, rather than divulge the names of the parties by whom he was supplied. The seller, therefore, must not be let off too easily, especially when he attempts to screen the perpetrator of adulteration.

The following are the steps recommended by the Committee for the Discovery and Suppression of Adulteration.

"It will be desirable," states the Report, "therefore to empower municipal or other local or district authorities, to appoint an officer or officers, who, on complaint made, or in cases of reasonable suspicion, shall procure portions of any articles supposed to be adulterated, with a view to their examination or analysis by some duly qualified person appointed for that purpose. On the report of such person, if it confirm the suspicion of adulteration, a summons shall be issued and the case be investigated before the justices, who shall have power to inflict summary punishment, by fine or imprisonment, in every case where pecuniary fraud or danger to health shall have been proved. It is essential that a right of appeal should lie to the Court of Quarter Sessions.

"With regard to coloured confectionary, your Committee recommend that authority should be given to local boards of health or other governing bodies to forbid the use for colouring of all mineral matter, and all poisoning vegetable matter.

"But although your Committee desire to leave the execution of the law against adulteration in the hands of the local authorities, they are of opinion that very valuable assistance would be afforded to such bodies in ascertaining the fact of adulteration, if one or more scientific analysers were to be appointed under the authority of the General Board of Health, to whom the local authorities might refer whenever they thought fit."

The Committee do not make any special recommendations in regard to the adulteration of drugs.

"Your Committee are of opinion that no inspection at the outports would guarantee to the consumer the purity of commodities passing through the hands of intermediate parties; and the exclusion of impure drugs would operate injuriously, by interfering with the supply obtained by scientific processes, calculated to extract valuable matter, even from products seemingly almost worthless."

On this point also we differ from the Committee, because we believe that a system of inspection would be found to operate most beneficially. It has already been tried in America, and the plan has worked well. Supposing that, in accordance with the opinion of the Committee, no inspection at the chief places of import is established, what will happen? Adulterated drugs will be imported as heretofore, and will find purchasers; they will pass into the hands of the wholesale druggists, from them, again, into those of the retail chemist, and thus they will reach the consumer, who, finding that he has been supplied with an adulterated drug, will have no remedy; for, according to the report, the seller is not to be held responsible for adulterations of which he has no knowledge. These remarks apply, not only to drugs, but to many articles of food occasionally imported in an adulterated condition.

The suggestions of the Committee doubtless contain much that is good, as far as they go; but they do not go far enough, and hence they will not prove effectual. Their great defect is that they do not include any provision for a central board or authority such as we conceive to be essential. The organisation proposed in connection with the General Board of Health is, considering the magnitude of the evil, of too limited a character to effect much good. It is essentially necessary that there should be some well organised central authority, having a competent head: the construction and duties of this body have already been indicated. Suppose, in accordance with the recommendations of the Committee, the various local officers to be appointed; who is to determine whether they do their duty or not? Who is to advise and guide them in the discharge of that duty? And, finally, in what way are the facts in regard to adulteration, brought to light through their labours, to be made available for the general good? Now the formation of a board such as is indicated does not necessarily imply the institution of a new authority: the Analytical Board of the Excise, if remodelled and placed on a broader basis, might be made to answer the purpose fully. The reorganisation of this board is imperatively demanded; in its present state it is a disgrace to the country. The correctness of this statement we shall proceed to prove.

The question may next be considered to *what extent the new machinery proposed to be called into operation for the suppression of adulteration will clash with the duties and position of the Excise in regard to adulteration.*

One of the chief duties entrusted to the Excise is the protection of the revenue (of which no inconsiderable portion is derived from duties on exciseable articles of consumption) from loss arising out of the adulteration of those articles. Amongst the articles bearing an Excise duty, and for the adulteration of which the Excise are responsible, are tea, coffee, cocoa, pepper, spirits, and tobacco, including snuff. Now, it may be inquired, do the Committee propose that the purchasers and analysts whom they desire to be appointed should occupy themselves with the adulteration of the several articles enumerated? If so, they would be actually discharging the duties for which the Excise are paid and responsible, and thus that body would be, to a great extent, superseded. On the other hand, supposing that these articles are still reserved for the Excise to deal with, what would then be the state of the case? Just this, that the revenue would still continue to be defrauded to a large extent, and the public health injured, as they have been for years past, by the prevalence of an enormous amount of adulteration in exciseable articles, and nearly all of which adulterations, under a thoroughly effective system of management, might be prevented. This brings us to consider the question, *how far the Excise has hitherto protected the revenue from loss through adulteration.*

The articles under Excise supervision have already been enumerated. Of these articles, *tea* is still subject to considerable adulteration, while the extent to which the public are defrauded in *coffee* and *cocoa* is notorious; they are also largely defrauded in pepper, spirits, and tobacco, as is proved by the following results of analyses of those articles as supplied to the public, and as reported in "The Lancet."

Of numerous samples of black and white *pepper* analysed, fully one-half were adulterated with ground rice, pea-flour, wheat-flour, linseed meal, and mustard husk.

Of thirty-eight samples of *gin* examined, a very large proportion were adulterated, some of them being reduced in strength one-half, while seven of them contained cayenne pepper. The same was the case with *rum* and *brandy.*

Of forty-three different *snuffs* examined, nearly all were adulterated, the adulterating ingredients used being, for the most part, salt, alkalies, silica, red and yellow ochre, red lead, chromate of lead, and chromate of potash.

The Excise, then, has most signally failed in its principal duty—namely, the protection of the revenue against adulteration.

The proof that it has thus failed is furnished in the fact that, at the time of the publication of the author's reports in "The Lancet," adulteration was ascertained, on evidence the most incontrovertible, to prevail in every one of the articles subject to the supervision of the Excise. Now this state of things ought not to be, and it is one which is discreditable to the Government of this country.

The *causes of the failure of the Excise* may next be considered: they are several; but we do not propose to do more at present than just, in the briefest possible manner, refer to one or two of those causes.

One reason is the want of sufficient activity and vigour in enforcing the powers with which they are intrusted. Compared with the prevalence of adulteration, how seldom do they make exposures of adulteration, and institute prosecutions!

Another reason is that they do not sufficiently employ the resources of science for the discovery of adulteration. They rely too much upon the information of Excise inspectors, and too little upon science, upon the resources of chemistry, but more especially upon a knowledge of vegetable structure as revealed to the competent observer by means of the microscope.

From not employing science enough, the Excise has, for the most part, in order to discover evidence of adulteration, been driven to adopt a system of espionage, and to the rude and inquisitorial proceeding of entering forcibly upon suspected premises, and of seizing on any adulterated articles or substances employed in adulteration, and which, perchance, they might find in the course of their search. The method adopted by "The Lancet" Commission was in striking contrast to this. It simply purchased the different articles as sold in the ordinary way of business, and applied to their analyses all the resources of science, especially the microscope and chemistry. By this proceeding it was not necessary, as in the case of the Excise, to maintain an army of "4000" Excise inspectors, neither was it requisite to violate the sanctity of men's private dwellings.

That the Excise had not employed science, either sufficiently or effectively, for the detection of adulteration, at the period of the commencement of our investigations, is proved by many circumstances.

Thus we found a variety of chemical adulterations to prevail, of which the Excise possessed no knowledge; but it was in respect to the use of the microscope, as an instrument for the discovery of adulteration, that its knowledge was the most defective. Of this ignorance it has itself furnished a memorable and striking proof. In 1850 repeated remonstrances were addressed to the Government to prohibit the adulteration of coffee with chicory. The Government excused itself from interfering, on the plea, publicly urged by the then Chancellor of the Exchequer, Sir Charles Wood, in the House of Commons, that, neither by chemistry, nor by any other means, was the adulteration of coffee with chicory to be detected. This statement was made on the strength of a report, procured at the instance of the Excise, from three of the most distinguished chemists of the day; the real fact at the same time being, that nothing is more easy or certain than the discovery of the adulteration in question, by means of the microscope. Further, we have within the last few years brought to light, with the aid of the microscope, hundreds of adulterations, the existence of which was utterly unknown to the Excise. Even now, although we have done so much to teach that body the use of the microscope, it has as yet failed to afford the public any evidence to show that it is capable of employing that instrument aright for the discovery of adulteration. It not unreasonably might have been expected, that a numerous and public body like the Excise, instituted and paid for the special work of discovering adulteration, with the most ample opportunities and facilities, would not have required to be taught its business by those engaged in prosecuting the subject of adulteration in a private and unofficial capacity.

It might also have been reasonably expected not only that it would not require to be taught itself, but that it would have published from time to time, for the information and guidance of the public, some instructions calculated to put it on its guard against adulterations, and to teach it, to some extent, how to detect them.

We learn from the Report of the Select Committee on Adulteration, that, "in addition to about 4000 officers scattered over the country, the Board (of Excise) employs about sixty to seventy analytical chemists, whose numbers are recruited by students educated for the purpose at University College, to the number of fourteen in every year." Why, here is a whole army of inspectors and analysts! With such huge machinery as this, the wonder is that adulteration should exist in any degree, much less that it should be all-prevalent! Had we the organisation and control of such an enormous staff, we would undertake to all but eradicate adulteration from the land.

Now, it must be remembered that the chief duty of this large force is simply to protect the revenue against fraud in some half dozen articles of consumption. With adulteration, as such—with the great mass of adulterations, whether they are injurious to health, or whether detrimental to the revenue—the Excise concerns itself not. Singular to relate, there are a variety of articles of consumption which pay duty to the State, which help to augment the revenue, and which are notoriously adulterated, and yet the Excise does not take cognisance of the adulteration of such articles.

It thus appears that the Excise has the smallest possible amount of duty to perform in connection with adulteration, and yet this, small as it is, is most inefficiently performed. There is no reason whatever why this discreditable state of things should exist. The present machinery of the Excise, remodelled, might be made to act against adulteration with enormous effect.

Another reason is that it does not avail itself sufficiently of the advantages to be derived from free publicity. We are disposed to rely more upon the regular publication of the names and addresses of those whose goods have been analysed, for the suppression of adulteration, than upon any other means, in consequence of the excellent effects which have undoubtedly resulted from the publication in "The Lancet," for a period of four years, of the names of upwards of 2000 merchants and tradesmen. So great has been the effect of this publication, combined with the recent exposures before the Parliamentary Committee, that we are of opinion that not one-twentieth part of the adulteration now prevails, in the metropolis at least, that did at the time when the reports of "The Analytical Sanitary Commission" first appeared. In some articles the improvement is manifest to the eye alone, as in the red sauces, pickles, bottled fruits and vegetables, and coloured sugar confectionary.

The following remarks, in reference to the publication of the names of traders in "The Lancet" and the effect produced by the microscope, occur in the "Quarterly Review" for March, 1855, in a review of the author's work entitled "Food and its Adulterations."

"A gun suddenly fired into a rookery could not cause a greater commotion than did this publication of the names of dishonest tradesmen; nor does the daylight, when you lift a stone, startle ugly and loathsome things more quickly than the pencil of light, streaming through a quarter-inch lens, surprised in their native ugliness the thousand and one illegal substances which enter more or less into every description of food which it will pay to adulterate. Nay to such a pitch of refinement has the art of fabrication of alimentary substances reached, that the very articles used to adulterate are themselves adulterated; and while one tradesman is picking the pockets of his customers a still more cunning rogue is, unknown to himself, deep in his own."

No objection, we believe, exists to the scheme which we have briefly set forth for the discovery and prevention of adulteration, on the score of expense; on the contrary, while an immense saving would ensue to the consumer, the revenue would be greatly benefited and the public health protected. The requisite machinery is in existence at the present time: as has before been stated, there is an enormous and costly machinery at work for the prevention of the adulteration of some half dozen exciseable articles,—that of the Excise,—consisting of some 70 chemists and 4000 inspectors. The Excise however, has failed to accomplish, to a great extent, this single object: further, it takes no cognisance of the adulteration of many duty-paying articles, as spices, arrowroot, &c., although this immediately affects the revenue; nor does it notice those adulterations which are simply frauds upon the consumer, or which are detrimental to the public health: thus it does not interfere with the adulterations of drugs, nor does it interdict the use of poisonous pigments in the colouring of sugar confectionary, &c. Nearly all, therefore, that appears to be requisite in order to insure, to a very great extent, the suppression of adulteration, *is to remodel the detective and analytical departments of the Excise, and to enlarge the sphere of its operations.* The analytical department should be made to take cognisance of all adulterations, whether in duty-paying articles or in articles free of duty. The best way would be either to place the remodelled analytical department of the very unpopular Excise under the Board of Health, the various Customs and Excise detective inspectors communicating with the reconstituted Board, or else to render it independent and distinct.

Some such change as that here recommended is imperatively demanded, and must ere long take place. It is impossible to allow the Analytical Board of the Excise to remain much longer in its present anomalous and most inefficient condition. This change effected, the Board would lose its arbitrary and objectionable character; it would cease to be regarded as an engine for the extortion of money; but while it really and effectually protected the revenue, it would at the some time protect the interests of the honest trader, of the consumer, and also become a guardian of the public health.

We are sorry that our views differ so much from those expressed by the Select Committee of the House of Commons on Adulteration; but we have felt ourselves constrained to give free expression to our opinions on this question which so closely concerns the interests of the public, and which are paramount to all other considerations. With abundant evidence of a most conclusive character, with a case which the Committee themselves acknowledge to be fully proved, it must be confessed that the Report is a very weak and timid one, when the gigantic character of the evil to be remedied is considered. It would appear as though the Committee, from the universality of the practice 'of adulteration, and from its extensive ramifications throughout the highest and the lowest branches of trade, had become alarmed, and shrank from grappling with it in a bold and comprehensive manner. Notwithstanding, however, that the Report falls short of what is required, it is yet a highly important document, and one which must be followed by legislation. The grateful thanks, therefore, of the public are fully due to the able chairman of that Committee, Mr. Scholefield, M. P., and his colleagues, namely, Viscount Ebrington, Viscount Gooderich, Lord Claude Hamilton, Hon. C. P. Villiers, Hon. W. Cowper, Mr. Alderman Cubitt, Mr. Gregson, Mr. Kinnaird, Mr. Knight, Mr. Peacocke, Mr. Otway, Mr. Swift, Mr. Sheridan, and Mr. Wise. Mr. Moffat, we suppose, was placed upon the Committee to represent the case of the adulterators. For two sessions these members of the House of Commons—all volunteers for the duty—were unremitting in their attendance at the meetings of the Committee, and they elicited from the various witnesses, by their well-directed inquiries, a mass of most valuable evidence, which cannot but result ere long in a great public benefit.

Various grounds exist, which render it imperative that some effective legislation should promptly be carried into effect for the suppression of adulteration.

Legislation on the subject is required—

First.—*For the Protection of the Public Health.*—The evidence given before the Parliamentary Committee on Adulteration proves that the deadliest poisons are daily resorted to for purposes of adulteration, to the injury of the health, and the destruction of the lives, of thousands. There is scarcely a poisonous pigment known in these islands which is not thus employed.

Second.—*For the Protection of the Revenue.*—This will be readily acknowledged when it is known that nearly half the national revenue is derived from taxes on food and beverages. It has already been shown that not long since adulteration was rife, and it still exists to a large extent in nearly all articles of consumption, both solid and fluid, and including even those under the supervision of the Excise.

Third.—*In the Interests of the Honest Merchant and Trader.*—The upright trader is placed in a most trying and unfair position in consequence of adulteration. He is exposed to the most ruinous and unscrupulous competition; too often he is undersold, and his business thus taken from him. It is therefore to the interest of the honest trader that effective legislation should take place, and not only is it to his interest, but we can state that it is his most anxious desire that adulteration should be abolished. In advocating the suppression of adulteration, we are therefore advocating the rights and interests of all honourable traders.

Fourth.—*For the sake of the Consumer.*—That the consumer is extensively robbed through adulteration, sometimes of his health, but always of his money, is unquestionable. It is, however, the poor man, the labourer, and the artisan, who is the most extensively defrauded; for, occupied early and late with his daily labour, often in debt with those with whom he deals, he has no time or power to help himself in the matter, and if he had the time he still would require the requisite knowledge. The subject of adulteration, therefore, while it concerns all classes, is eminently a poor man's question; the extent to which he is cheated through adulteration is really enormous.

Fifth.—*On the Ground of Public Morality.*—Adulteration involves deception, dishonesty, fraud, and robbery, and since adulteration is so prevalent, so equally must these vices prevail, to the serious detriment of public morality, and to the injury of the character of the whole nation, for probity, in the eyes of the world. Under this head we cannot do better than quote the language of the Parliamentary Committee on Adulteration. "Not only," states the Report, "is the public health thus exposed to danger, and pecuniary fraud committed on the whole community, but the public morality is tainted, and the high commercial character of this country seriously lowered, both at home and in the eyes of foreign countries." We repeat, then, that some prompt, active, and efficient legislative interference is demanded, for the sake of public morality, and the character of this country amongst the nations of the world.

But there are yet other reasons for legislation. It cannot be doubted but that, in making known the nature of the adulterations practised upon a variety of articles, although we have deterred some, yet have we also taught many the way to adulterate, and of this knowledge they will not be slow to avail themselves, especially in the absence of any sufficient check. The recent startling and frightful exposures, although they have done good for a time, will, if unsupported, serve but to increase the evil at some future day.

A reluctance is expressed in some quarters to grapple with the giant evil of adulteration from the fear lest it should interfere with, and impose restrictions on, trade. This fear we believe to be groundless; and even if there were some foundation for it, yet it ought not to be allowed to prevail against what our consciences tell us to be right. Trade is one thing, poisoning our food another. Surely there is no necessary connection between the two; and if connected, the sooner the connection is severed the better — the better on all grounds, and especially it will be to the advantage of trade itself. We maintain, however, that the connection which now exists is entirely unnatural, that it has sprung up under a careless and loose state of things, and that it is the duty of the State to interpose its authority for the prevention of adulteration.

Now it should be clearly understood that it is not necessary for the suppression of adulteration that restrictive measures should be resorted to, calculated to interfere with trade, or to impede the liberty of the subject, beyond those already in existence; indeed some of the restrictions now in force, and interference at present in operation, might, under a better organisation, be discontinued.

Let us recall to mind the powers already conferred for the suppression of adulteration. The Excise is at liberty to enter, by force, upon any premises, where the adulteration of an exciseable article is suspected to be carried on, or where adulterated goods are supposed to be deposited; the adulterators or sellers of adulterated articles may be apprehended, punished by fines, which are sometimes very heavy, or imprisonment; all the adulterated articles may be confiscated, as well as the implements employed in their preparation. The Board may lock up a manufacturer's premises, taking the keys away, even when he is not practising adulteration, and it may control the processes of manufacture therein pursued. Here is interference with the freedom of trade and the liberty of the subject, with a vengeance!

Again, magistrates or peace officers, by warrant, under the Bread Act, may search any premises and seize any adulterated flour or bread, search for any forbidden ingredient, inflict the penalties of fine and imprisonment; and lastly, they may publish the names of the offenders.

To prevent smuggling,—an offence which, in its effects upon the revenue, is allied to adulteration,—a large force, armed to the teeth, is stationed all around the coasts of these islands: it may seize the smuggler, and, if he resist, kill him; or it may take his contraband goods from him, and, on conviction, cast him into prison. Here, again, is interference with the liberty of the subject; and; remember, in smuggling, the revenue only is defrauded, and but little is thought of public health or morality.

Lastly, recall to mind the powers exercised, and properly so, in the cases of bad or diseased meat, and of short weights and measures, which, be it known, often go along with adulteration. In such cases there is the power of entering upon suspected premises, of seizing and confiscating the articles, and of punishing the wrongdoers by fine or imprisonment.

It may be inquired, how comes it that, with such powers of repression, adulteration so prevails? The answer is, that the laws in force respecting adulteration are partial only in their operation; that they relate only to certain articles; that they are for the most part but seldom enforced; and that some of them have even fallen into desuetude. What concerns everybody, what is everybody's business, becomes, in fact, according to the old adage, nobody's business.

The cries of "freedom of trade" and "the liberty of the subject," in connection with adulteration, are in reality unmeaning terms, used as bugbears to frighten the timid and to throw the public off their guard. We repeat, then, RESTRICTIVE MEASURES, BEYOND THOSE ALREADY IN EXISTENCE, CALCULATED EITHER TO IMPEDE THE FREEDOM OF TRADE OR TO CURTAIL THE LIBERTY OF THE TRADER OR THE SUBJECT, ARE NOT REQUIRED FOR THE SUPPRESSION OF ADULTERATION. WHAT IS *NEEDED* IS AN EFFECTIVE SCIENTIFIC ORGANISATION FOR THE DISCOVERY OF ADULTERATION, AND THE ADEQUATE PUNISHMENT OF THE OFFENCE.

ON THE MEANS BY WHICH ADULTERATION MAY BE DETECTED.

There are two principal means by which the discovery of adulteration is effected, *chemistry* and the *microscope*.

Chemistry has been long employed for the detection of adulteration, and it was upon this means of investigation that the earlier observers almost exclusively relied.

The application of the microscope to the detection of adulteration is comparatively new, and dates chiefly from the period at which my paper on the Adulteration of Coffee was communicated to the Botanical Society of London, that is from August, 1850.* This is certainly the most practical and important use which has ever been made of that instrument; for by its means hundreds of adulterations have been discovered, the detection of which was beyond the power of chemistry, and which had previously eluded all the efforts of science. The author believes that he may claim to have been the first to employ on a large scale the microscope for the discovery of adulteration; on this point, however, the language of others may be employed.

"The Lancet," in reviewing the author's work on the Adulteration of Food, writes, January, 1855: "It is now unnecessary to say how completely Dr. Hassall dispelled the delusion as to the circumscription of science, and how he demonstrated that the microscope, wielded by the skilful naturalist and chemist, was able to unravel and to analyse the component structures of substances that bid defiance to the blowpipe and the test-tube alone. It is the great and original merit of Dr. Hassall to have applied the microscope to important uses in inquiries of this nature, and to have shown, by its uses, not only many things previously considered impossible to show, but many things not previously suspected to exist."

The "Quarterly Review," in an article on the same subject, remarks: "It is in the application of the microscope that consists Dr. Hassall's advantage over all previous investigators in the same field. The precision with which he is enabled to state the results of his labours leaves no appeal."— March 1855.

The "Dublin Review" remarks: "The secret of his success has been that, in addition to chemical analysis, he has used the microscope in his inquiries; and his merit not only consists in the able manner in which he has employed the instrument, but in his being the first to use it practically and to such an extent for this purpose."

"The microscope," writes "The Times," † referring to our labours,

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* See "Times," August 5. 1850.

† July 24. 1855.

"seems to have been the more effective instrument in the work. Less than five years ago it would, we are told, have been impossible to detect the presence of chicory in coffee. In fact, the opinion of three distinguished chemists was actually quoted in the House of Commons to that effect; whereas by the use of the microscope the differences of structure in these two substances can be promptly discerned."

Lastly, the following remarks from the pen of a very able writer, Dr. Robert Barnes, may be quoted: "The scientific originality of Dr. Hassall's labours in laying bare the health-destroying and fraudulent adulterations of food and drugs, is, if possible, still more meritorious; and it would be difficult to over-estimate the public importance of the results obtained. The means previously relied upon to check these adulterations were, the cumbrous and costly machinery of the Excise, and the subsidiary aid which chemistry could afford. The officers of the Excise were, for the most part, driven to seek for evidence by forcible entry and the seizure of articles found on suspected premises. When the art of the chemist failed, science was practically exhausted. So late as 1851, the then Chancellor of the Exchequer was able to quote in the House of Commons, as the deliberate opinion of three of the most distinguished chemists of the day, who had been specially requested to report upon the subject, "*that neither by chemistry nor by any other means could the admixture of chicory with coffee be detected.*" How completely this foregone conclusion has been exploded by the labours of Dr. Hassall, as Analyst of the Sanitary Commission of "The Lancet," is notorious. There is now nothing in science more certain and precise than the discrimination, by means of the microscope, of the various forms of vegetable tissues, no matter to what extent they may be pulverised, mixed, or even roasted.

"The interest of Dr. Hassall's researches is universal. They have benefited the public revenue, every man in health or in sickness, and the physician who trusts in the properties of the agents, whether medicinal or dietetic, which he prescribes; and Parliament has been informed through them of new grounds and new principles of legislation. The great importance of the subject of the adulteration of food, drink, and drugs, has already been recognised by Parliament, and this mainly through the labours of Dr. Hassall."

ON THE APPLICATION OF THE MICROSCOPE TO THE DETECTION OF ADULTERATION.

The microscope is specially suited to the detection of organised structures or substances, as the several parts of animals and plants: it is with the latter that we shall chiefly have to do in the course of the present work.

When we survey with our unaided vision any animal or plant, we detect a variety of evidences of organisation or structure; but there is in every part of every animal or vegetable production an extraordinary amount of organisation, wholly invisible to the unarmed sight, and which is revealed only to the powers of the microscope. Now this minute and microscopical organisation is different in different parts of the same animal or plant, and different in different animals and plants, so that by means of these differences, rightly understood, the experienced microscopical observer is enabled to identify in many cases infinitely minute portions of animal or vegetable tissues, and to refer them to the parts or species to which they belong.

Thus, by means of the microscope, one kind of root, stem, or leaf may generally be distinguished from another, one kind of starch or flour from another, one seed from another, and so on. In this way, the microscope becomes an invaluable and indispensable aid in the discovery of adulteration.

Applying the microscope to food, it appears that there is scarcely a vegetable article of consumption, not a liquid, which may not be distinguished by means of that instrument. Further, that all those adulterations of these articles which consist in the addition of other vegetable substances, and which constitute by far the majority of adulterations practised, may likewise be discovered and discriminated by the same means.

The same remarks apply to all the vegetable drugs, whether roots, barks, seeds, or leaves. We are not acquainted with one such drug which may not be thus distinguished.

The seeds even belonging to different species of the same genus may frequently be distinguished from each other by the microscope, a point in some cases of very great importance. A remarkable instance of this has fallen under our observation. The seeds of the different species of mustard, rape, &c. may all be distinguished under the microscope by differences in their organisation. To show the importance of the discrimination in some cases, the following instance may be cited. Some cattle were fed with rape cake, and died with symptoms of inflammation of the stomach and bowels. Nothing of a poisonous nature could be detected on analysis; but it was suspected that the cake might be adulterated with mustard husk, although even this point could not be clearly established by chemical research. Under these circumstances the cake was sent to the author for examination, who had but little difficulty in ascertaining that it was adulterated with mustard seed, which, from the large quantity consumed, was doubtless the cause of the fatal inflammation. Not only can the seeds of different plants of the same genus be frequently discriminated by the microscope, but in some cases those belonging even to mere *varieties* of species.

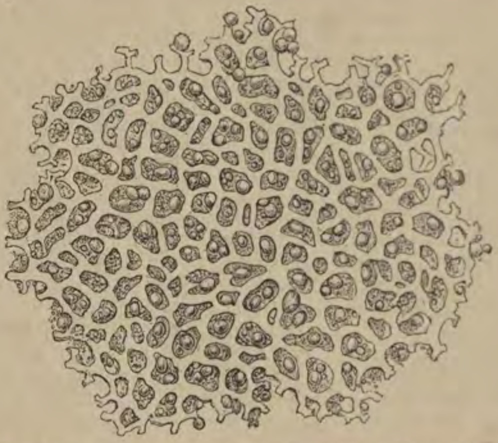
The microscope in some cases can even inform us of the processes or agents to which certain vegetable substances have been subjected. Illustrations of this are afforded by the starches of wheat and barley: it can be determined by the microscope whether these are *raw*, *baked*, or *boiled*, or whether *malted* or *unmalted*. Illustrative figures will be found in the articles on Bread and Beer.

Again it is not only when the articles are in a separate state that they can be thus distinguished; but even when mixed together in different proportions. We have succeeded in detecting in certain vegetable powders no less than nine different vegetable productions.

So great and manifest are the differences revealed by the microscope in different vegetable substances, that, with ordinary care and some amount of preliminary knowledge, the discrimination becomes a matter of the greatest ease and the most absolute certainty.

This will appear even from an examination of the five following figures.

Fig. 1.



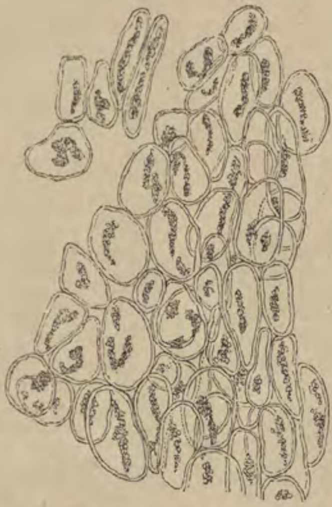
Section of Unroasted Coffee Berry, showing the size and form of the cells, as well as the drops of oil contained within their cavities. Drawn with the Camera Lucida, and magnified 140 diameters.

The above figure represents a section or fragment of the unroasted coffee berry: if the reader will contrast this with the next figure, which represents a small fragment of chicory root, he will perceive how great is the difference; so with the starch granules of the different arrowroots; of wheat, rye, rice and Indian corn flours; with jalap and rhubarb; and with a variety, we might say a host, of other substances. Now chemistry could not furnish us with the name of even one of these different starches.

Further, wonderful to relate, the grinding and pulverisation, and even the charring, of many vegetable substances, does not so destroy their structure as to render their identification by the microscope impossible. Chicory and coffee may be thus roasted and pulverised, and yet each may be subsequently identified with the greatest ease, they being in fact but little changed, except in colour, and in the case of coffee by the dispersion of the droplets of oil visible in the cells of the unroasted berry.

Again, substances may be discovered by means of the microscope, even when introduced into articles for the purpose of adulteration in extremely minute quantities : the case of some mustard forwarded by a manufacturer to "The Lancet" some time since furnished a remarkable illustration in point.

Fig. 2.



Fragment of ROASTED CHICORY ROOT, taken from a sample of adulterated coffee, showing the *cells* of which it is principally constituted. Drawn with the Camera Lucida, and magnified 140 diameters.

The mustard was stated to be genuine ; but on examination with the microscope, it was found to contain a small quantity of turmeric. The manufacturer, when informed of the fact, very candidly and properly acknowledged that this was the case, and stated that he had added "*two ounces of turmeric to fifty-six pounds* of seeds, not for the purpose of gain or adulteration, but simply to enliven the colour and make its appearance more acceptable;" that is, the quantity of turmeric present, and discovered by the microscope, consisted of only *one part in* 448 of the quantity examined.*

The last illustration — and a very striking and beautiful one it is, although not immediately connected with the subject of adulteration,— which we shall adduce in order to show the extraordinary character of the information furnished in some cases by the microscope is supplied by honey.

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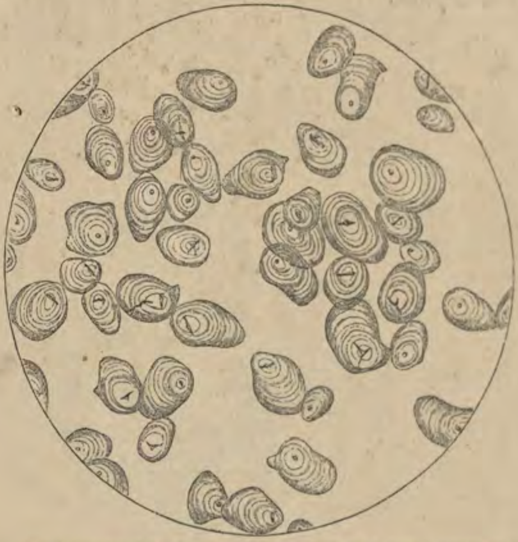
* Food and its Adulterations, p. 132.

Honey is the saccharine exudation from the nectaries of flowers: the bees in collecting it carry away some of the pollen of the flowers visited by them. Now this pollen consists of cells or vesicles, differing in size, form, and structure, according to the plants from which it is derived, certain plants being characterised by pollen granules of a certain configuration and organisation. By the pollen present in honey, therefore, the scientific microscopist acquainted with the characteristics of the pollen of different plants is enabled to decide in many instances upon the nature of the plants from which the honey has been procured, and whether it has been collected from the flowers of the field, the garden, the heath, or the mountain. See article HONEY for figure in illustration.

Fig. 3.

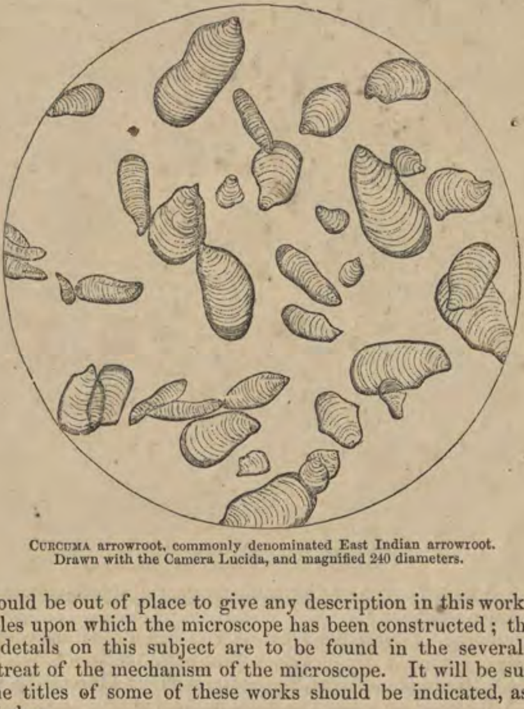


Starch granules of MARANTA, called commonly West Indian arrowroot. Drawn with the Camera Lucida, and magnified 240 diameters.

There is still another use to which the microscope may be applied in the detection of adulteration; it may frequently be made to serve as an auxiliary to chemical researches: thus, for example, when we want to ascertain whether any substance contains starch, carbonates, phosphates &c., it is often the quickest and most certain way to apply the reagents to a small quantity of the substance while this is under the field of vision of the microscope.

What the microscope is capable of effecting in the discovery of adulteration having been thus explained, *the mode of the application of that instrument to the subject* may next be considered.

Fig. 4.



CURCUMA arrowroot, commonly denominated East Indian arrowroot. Drawn with the Camera Lucida, and magnified 240 diameters.

It would be out of place to give any description in this work of the principles upon which the microscope has been constructed; the most ample details on this subject are to be found in the several works which treat of the mechanism of the microscope. It will be sufficient that the titles of some of these works should be indicated, as those given below.

"The Microscope, its History, Construction, and Applications." By Jabez Hogg, Esq., M. R. C. S. Price 7*s.* 6*d.* Routledge & Co.

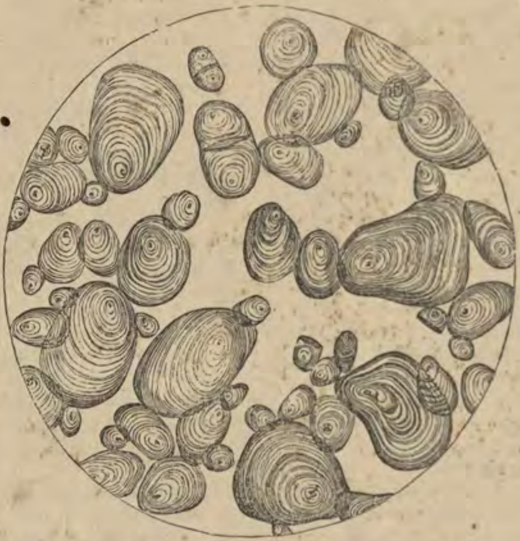
"The Microscope." By Dr. Beale. John Churchill.

"A Practical Treatise on the Microscope." By Prof. Quekett. Price 21*s.* H. Baillière, Regent Street.

It is advisable, however, that a few remarks should be made upon the very important subject of the cost of a microscope suitable for the discovery of adulteration.

The cost of a microscope suitable for the purpose varies much according to the maker, the character of the stand, and the nature and number of the object-glasses or powers with which it is furnished.

Fig. 5.



POTATO arrowroot, commonly called British arrowroot. Drawn with the Camera Lucida, and magnified 240 diameters.

If supplied with French or German achromatic object-glasses, it may be put down at about 10*l.*

M. Pillischer, of New Bond Street, supplies a *Students*' or *Medical microscope*, sufficient for ordinary purposes, for 7*l.* 7*s.* It consists of microscope stand complete, but without stage movements, quarter and inch object-glasses, one eye-piece, and mahogany case.

Mr. Baker, of High Holborn, supplies *Students' microscopes* suitable for physiological purposes, and furnished with case and three achromatic powers, 1-inch, ½-, and ¼-inch, for 4*l.* 15*s.* and 5*l.* 15*s.* each. The object-glasses may also be purchased separately of Mr. Baker.

The Society of Arts prize microscope, manufactured by R. Field and Son, of 113. New Street, Birmingham, is furnished with case, two eye-pieces, and two object-glasses, at a cost of 3*l.* 3*s.* This instrument we have not seen.

Smith and Beck's *Educational microscope* consists of two object-glasses, the 1-inch and ¼-inch; two eye-pieces; a firm stand, with a joint for varying the position, quick and slow motions to the body; a stage with springs that allow any motion to be given to the object; concave mirror; a side condensing lens; forceps, glass plates, pliers: all packed in mahogany case. Its cost is 10*l.* Address, 6. Coleman Street, City.

Messrs. Powell and Lealand furnish, for 13*l.* 13*s.*, an instrument of the following description. It has a very firm tripod stand, with coarse adjustment by rack and pinion; two eye-pieces; two object-glasses, namely, ¼- and 1-inch; diaphragm and stops: the whole packed in mahogany case. For 2*l.* 2*s.* more the ½-inch object-glass may be substituted for the inch. Address, 4. Seymour Place, New Road. The glasses supplied by Messrs. Smith and Beck, and Messrs. Powell and Lealand, are English made.

It does not appear that Mr. Ross manufactures any cheap microscope suitable for the purpose.

A very excellent and cheap microscope stand, which we are much in the habit of recommending, is made by Mr. Byles of 96. St. John Street Road. It has the double stage movements, the advantage of which is very great, a fine adjustment, and an excellent mirror, and is remarkably cheap at *5l. 5s.* For 2*l.* 7*s.* more, two very good German achromatic glasses may be procured of Mr. Baker, namely, the ½- and ¼-inch. This microscope, is very well suited for the detection of adulteration.

It is desirable, although not absolutely necessary, that whatever microscope may be purchased should be furnished with a polariscope, as this will be found extremely useful in the discrimination of some of the starches.

The object-glasses most useful for the detection of adulteration are the ½- and ¼-inch glasses; it is not very often that the ⅛-inch glass is required, although it is necessary in some cases, as in the examination of the smaller starch granules, as those of rice, liquorice, &c.

For different objects different magnifying powers are requisite. What these should be may be ascertained in general by reference to the descriptions attached to the various engravings scattered throughout the work. It is well to accustom oneself as far as possible to the examination of objects with the same glasses, as in this way different objects may be more readily compared the one with the other.

The examination of objects is in some cases facilitated by employing in the first instance an object-glass of low magnifying power, as the 1-inch or ½-inch, and subsequently having recourse to a higher power to make out the details.

It is desirable also that the microscope used should be provided with two or three eye-pieces, as by this means we are furnished with intermediate ranges of magnifying powers.

The maker supplying the instrument should always furnish a printed table stating the number of diameters which each object-glass and eyepiece magnifies. The following table shows the extent to which the different object-glasses and eye-pieces are usually made to magnify. It applies more particularly to the glasses manufactured by Mr. Ross.

Eye-glasses.	Object-glasses.					
	2-in.	1-in.	⅔-in.	¼-in.	⅛-in.	1/12-in
A.		60	100	220	420	
B.		80	130	350	670	
C.		100	180	500	900	
Value of each space in the micrometer eye-glass with the various object-glasses.		$\frac{1}{970}$ = ·001031	$\frac{1}{1900}$ = ·0005263	$\frac{1}{4300}$ = ·0002325	$\frac{1}{9000}$ = ·0001111	

In addition to the microscope, it is necessary that the observer should be furnished with glass slides, cells, and thin glass covers, with mounted needles, and also, if he desires to preserve permanently any of the objects he meets with, with a preserving fluid, and with a cement to secure the cells and covers. The cells, slides, and covers, may be obtained of most microscope makers, of Mr. Baker, Holborn, or of Mr. Bender, 6. Brunswick Place, City Road.

Several *fluids* are used for the exhibition and preservation of microscopic objects.

One of these is Canada balsam, diluted with turpentine to such a consistency as to allow of its dropping readily from a pencil.

Mr. Deane recommends the following composition for preserving dry or moist animal or vegetable substances:—Of White's patent size or gelatine 6 ounces by weight, honey 9 ounces, a little spirits of wine, and a few drops of creosote; mix and filter whilst hot.

Another composition is thus made:—Pure glycerine 4 fluidounces, distilled water 2 ounces, gelatine 1 ounce by weight; dissolve the gelatine in the water made hot, then add the glycerine and size.

Or pure glycerine only may be used.

The glycerine may also be used with the addition, when desirable, of salt, corrosive sublimate, creosote, or spirit.

Other preserving fluids are weak spirits and water; creosote and water, in the proportion of a drop or two of the former to 6 oz. of water; or creosote, a little spirit and water.

A very useful fluid for mounting crystals of salts is castor oil, first recommended by Mr. Warington.

The following are the receipts for the well-known solutions of Goadby. No. 1. Bay salt 4 oz., alum 2 oz., corrosive sublimate 2 grs., boiling water, 1 quart; mix. No. 2. The proportions of salt and alum are the same, but the quantities of corrosive sublimate and water are doubled.

Professor Quekett's preservative fluid is made of creosote 1½drachms, wood naphtha 2 oz., distilled water 32 oz., chalk as much as is required to make the creosote and naphtha into a paste; before adding the water the solution is allowed to stand for a day or two, and is then filtered; two small lumps of camphor are then added, and after the lapse of a week the solution is again filtered, when it is ready for use.

Of the several solutions named, none are so good for the preservation of most vegetable preparations as those containing glycerine or gelatine, either separately or combined. One advantage of glycerine is that it is not so highly refractive as Canada balsam, and another that moist objects may be put up in it without any previous drying.

The next best is perhaps Quekett's preservative fluid.

There are also several *cements* employed for closing the cells: one of these is shell-lac varnish; this is usually made by dissolving black sealing-wax in rectified spirit: it is best prepared, however, from the shell-lac itself. Two or three coatings or layers of this varnish should be used, applied in succession as the previous coating has become dry. It is not acted upon by weak spirit.

Another cement is gold size.

Gum-copal dissolved in oil of lavender also furnishes a useful cement.

Marine glue, much used for cementing the cells to the glass slides, consists of equal parts of shell-lac and India-rubber, dissolved in coal or mineral naphtha, the solution being carefully mixed afterwards by means of heat. It may be rendered thinner by the addition of more naphtha, and when hard it is readily dissolved by naphtha or ether. This is the cement used by Goadby.

The cement employed by Mr. Quekett for deep cells is made by melting together 2 oz. of black resin, 1 oz. of bees-wax, and 1 oz. of vermilion.

Mr. C. Brooke's cement consists of Brunswick black, to which a little India-rubber dissolved in mineral naphtha has been added.

Mr. Hett makes use of dark-coloured and old japanners' size, for securing the upper thin glass covers, and marine glue for the cells.

In using the cements care should be taken to select those which do not exhibit any affinity for the preserving fluid contained in the cells: thus no resinous cement should be employed when the contained fluid is spirituous.

For securing the glass cells to the slides marine glue is a good cement, and shell-lac varnish for closing the edges of the covers, where glycerine or castor oil is used.

For more detailed practical instructions in the mounting and preservation of microscopic objects, the reader is referred to the excellent work by Mr. Hogg, the title of which is given on page 49.

The various vegetable articles employed either as food or medicines, as well as the substances used for their adulteration, are mostly put up in some preserving fluid; and in general, as they consist either of thin sections or fine powders, cells are not required. All that is in general requisite is to deposit the section or a minute portion of the powder, taking care to diffuse it equally, in a drop of the liquid placed in the middle of the glass slide; to cover this with a square or circle of thin glass, observing that no air lies beneath it; to remove the superfluous moisture around the edges of the glass with blotting paper, and when quite dry to apply the cement by means of a fine-pointed brush.

The mode of preparing the objects for examination with the microscope may next be considered.

Before proceeding to the examination of any article with a view to discover whether it is adulterated or not, it is necessary to acquaint ourselves thoroughly with the appearance and structure of the article itself. If this be in the state of powder, as the different kinds of flour and arrowroot, nothing more is necessary than to place a very minute portion of it upon the glass slide, to add a drop or two of water, diffusing the powder evenly through it in a layer so thin that the light easily passes through it, to cover the object with one of the thin glass covers, and to place it in a proper position under the microscope for observation. If the vegetable substance be a solid one, as a root, stem, or seed, then it is necessary to make some thin sections of it, determining the structure from these. These sections are best prepared by means of a sharp and thin-backed razor: of these sections some should be longitudinal, others transverse, and others should embrace the surfaces of the object, both external and internal, where the latter exists. The examination is facilitated in some cases by tearing some of the sections in pieces with needles and also by examining them in glycerine in place of water, this rendering the structure more distinct. Lastly, where the article is one employed in the form of powder, it is necessary to prepare some of the genuine powder, and to make ourselves familiar with its structural characteristics.

Having progressed thus far in the examination of the article, we are in a position to scrutinise samples of it, with a view to the detection of adulteration. Knowing well the structures which are met with in the genuine article, we shall experience but little difficulty in determining whether the sample contains any foreign or extraneous vegetable substance, or consists entirely of the one article.

Having determined that it does contain such foreign substance, the next thing is to endeavour to ascertain the nature of this, and to refer it to the plant or substance to which it belongs. The facility with which this is done depends upon the extent of our acquaintance with other vegetable substances. If this be considerable, a glance is often sufficient to determine this point.

However, it is not requisite in all cases that we should possess a knowledge of the structure and appearances presented by any very great number of vegetable productions, since a few articles are constantly employed for adulteration in the case of very many and widely different articles, such as wheat flour, potato starch, sago powder, rice, &c.; and all that is necessary in such cases is that we should be able to recognise these substances when we meet with them.

Most vegetable substances are made up of certain structures and elements, as cellular tissue, woody fibre, vessels, starch granules, &c. In leaves we have stomata and often hair-like appendages, and in seeds there are two or more membranes. In endeavouring to discriminate between different vegetable substances, we must examine and compare most carefully these several tissues and structures the one with the other. We must compare, both for size and structure, the cellular tissue of one vegetable substance with that of another, and the same with the woody fibre, the vessels, the starch, &c.

Before proceeding to determine the minute structure of any vegetable substance by means of the microscope, we would strongly recommend the observer to look over some work on Structural Botany, and thus to become acquainted with the characteristics of the principal tissues and elements which enter into the organisation of the several component parts of vegetables. He should acquaint himself with the characters and structure of cellular tissue, woody fibre, vascular tissue, sclerous tissue, of starch granules, with the general structure of roots and stems, leaves, flowers including the pollen, and particularly with seeds. He will find a little preliminary study of vegetable anatomy facilitate greatly his subsequent and more special inquiries.

Any of the following works will be found suitable for this purpose.

"Outlines of Structural and Physiological Botany." Price 10*s*. 6*d*. By A. Henfrey. Van Voorst.

"Descriptive and Physiological Botany." Lardner's "Cyclopædia." By Prof. Henslow. Longmans & Co..

Schleiden's "Principles of Scientific Botany." By Lancaster. Longmans & Co.

Balfour's "Structural and Physiological Botany." Price 1*l*. 11*s*. 6*d*. Longmans & Co.

ON THE APPLICATION OF CHEMISTRY TO THE DETECTION OF ADULTERATION.

Chemistry is adapted particularly for the detection of the various chemical substances and salts used for adulteration: the microscope, on the other hand, as has been already stated, is specially suited to the detection of all organised structures and substances, whether animal or vegetable. Now it is precisely in this branch of investigation that chemistry fails to afford us any considerable aid.

Chemistry can tell us whether starch is present in any substance, but it is very seldom indeed that it can furnish us, as the microscope so constantly does, with the name of the plant from which the starch was derived: it can indeed also make us acquainted with the fact that woody fibre is contained in any particular article, but it cannot furnish us with the name of the tree or plant of which it formed a constituent.

Another great advantage of the microscope over chemistry is the greater speed with which results may be arrived at. Many chemical analyses occupy days, while most microscopical examinations may be made by the practised observer in the course of a few minutes. With the author's present knowledge, there are but few articles of which he could not examine readily 100 samples per week.

Nevertheless, the information supplied by chemistry in connection with adulteration is of the highest importance, and it is impossible successfully to study the subject of adulteration without having recourse constantly both to the microscope and chemistry.

The importance of chemistry, as applied to the discovery of adulteration, is shown by the fact that the majority of the substances injurious to health employed for adulteration can be detected with certainty only by chemical methods of research.

It will perhaps save loss of time hereafter, prevent disappointment, and remove some difficulties which may lie in the way of the beginner, if we now make a few observations on the chemical apparatus required for the detection of adulteration, and on certain chemical operations or processes constantly employed.

On the Chemical Apparatus required.

It is not necessary that the manner in which the laboratory should be fitted up should be described; this of course must be supplied with both gas and water, with benches and tables; the gas must be laid on at different points, and the jets provided with burners of different kinds.

Chemical analysis is of two kinds, qualitative and quantitative: the object of the first, as the name implies, is to ascertain the nature of the several component parts of any given compound; that of the second is to determine the proportions or quantities of such components.

The operations of qualitative chemical analysis are easier and occupy less time than those of quantitative analysis; and in many cases it is sufficient for our purpose to determine the nature of the chemical substance used for adulteration, and we need not go on to ascertain the quantity present in any article; although, when we desire to go thoroughly into the subject of adulteration, this also will in some instances be necessary.

The apparatus enumerated below includes the greater part of that which is required for both purposes.

For drying and evaporating.—A water, a sand, an air, and an oil bath, evaporating dishes of various sizes, and watch glasses.

For weighing and measuring.—A good balance (if for weighing very accurately fractions of a grain, Oertling's is the best); weights of brass and platinum; a specific gravity bottle, graduated pipettes, flasks, glasses of various sizes and measures; densimeters, as a saccharometer, galactometer and urinometer.

For filtration.—Funnel stands, funnels, and filtering paper.

For pulverisation.—Mortars; a mill.

For distillation.—A still, retorts, and condensers.

For Incineration.—Muffles, porcelain and platinum crucibles and dishes.

In addition to the above apparatus, test tubes, a lactometer, thermometer (one not mounted, and having a long range of degrees), a wash bottle, and a drop tube, will be required.

When it is probable that a large number of samples of the same article will have to be examined, and many similar operations conducted at the same time, it is desirable that special arrangements should be made with this view, and that we should be furnished with series of crucibles, glasses, dishes, &c. of the same size.

Any information which may be required respecting the apparatus employed may be readily obtained from the manufacturers and sellers of chemical apparatus.

On the Chief Preliminary Chemical Operations.

The chief preliminary chemical operations are those of weighing, measuring, desiccation, evaporation, filtration, decantation, distillation, and incineration. A few observations may now be made upon each of these processes.

Weighing.—The precautions to be observed in weighing are, for the most part, of a tolerably obvious character and require no special description. The substance, especially if it be in a dish or capsule, should not be weighed while warm; if it be one likely to absorb water it should be weighed enclosed in watch glasses; and if its weight is not determined immediately after being dried, it should be kept under a bell glass near to a dish of sulphuric acid. These precautions of course need not be observed in cases where the exact weight is not of material consequence, or where the quantity of the substance weighed is considerable and where it is not hygroscopic.

Measuring.— This process is had recourse to in the case of fluids, as it is more expeditious than weighing. The instruments used for this purpose are the graduated pipette, the graduated burette or dropping glass, the graduated cylinder or measure, and the graduated flask.

In measuring liquids in glass vessels, the dark zone formed by the adhesion of the fluid to the inner walls of the glass should be taken into account. The measuring is most accurate when the mark-line of the measure coincides with the lower border of the dark zone.

Desiccation.—Most substances contain more or less superfluous water, that is, water which is simply in a state of mechanical admixture, and not chemically combined with the substance; most solid bodies, therefore, require to be deprived of this non-essential water before they can be quantitatively analysed; and this is effected by the operation of drying. With the constitutional water we of course must not, in general, interfere.

To accomplish this object satisfactorily, it is requisite that we should be acquainted with the properties of the substance operated upon, whether it loses water simply in contact with the atmosphere, in air dried to 212°, or at a red heat. These data will serve to guide us in the selection of the process of desiccation best suited to the substance under examination.

Substances are dried by means of blotting paper, under a bell jar in contact with sulphuric acid, in the exhausted receiver of an air pump, in the water, air, and oil baths.

The majority of substances with which we shall have to deal being organic, lose water at 212° F. and are decomposed at a red heat; consequently they require to be dried in a water bath. When higher temperatures are needed, as in rendering certain salts anhydrous, the air or oil baths must be had recourse to.

The sand bath, although useful in many cases, requires to be employed with caution, as it is not easy to regulate its temperature, and organic substances placed upon it are readily charred and destroyed.

The capsule or dish containing the substance to be dried should not be placed directly upon the shelf of the water or oil bath, but a watch glass or porcelain dish should be interposed.

Evaporation.—Evaporation may be effected either in the water or sand bath, or over the flame of a gas or spirit lamp, care being taken to avoid loss from boiling or spurting. An expeditious way in most cases is to apply the heat by means of a flame of gas or spirit.

In order to shield the evaporating dish from contamination by dust or dirt, it is often necessary to protect the dish in some way; this may be effected by covering it with a sheet of filtering paper turned down over the edges; or a glass rod twisted into a triangular shape is laid upon it, and the paper spread over it and kept in position by a second glass rod laid across; but a still better way is to secure the paper between two small hoops fitting closely the one over the other.

Filtration.—Precipitates are separated from fluids by one of two processes, either by filtration or decantation. The requisites of a good filtering paper are that it should filter rapidly, and that it should not permit the precipitates to pass through it; there is a great difference in filtering paper in these respects. Another criterion is that, on incineration, it should furnish but a small amount of ash. Nearly all paper, unless specially prepared, contains impurities such as lime, magnesia, and sesquioxide of iron: in certain delicate operations it is necessary that these should be removed. This is easily effected by steeping the paper in a mixture of one part of pure hydrochloric acid to three parts of water, and subsequently washing it repeatedly with warm distilled water previous to drying. These operations are best conducted by placing a number of filters in a glass funnel.

It will be found convenient to prepare a number of filters in this way and to keep them of different sizes, registering the weights of the ashes, corresponding to the several sizes. This may be readily done by preparing some circular pieces of card-board to serve as patterns for the several sizes.

Before proceeding to filter any liquid for the purpose of separating a precipitate from it, it is in general advisable to allow the precipitate to subside to a great extent: in this way it is less liable to pass through the filter or the filter to become clogged.

It is in some cases necessary to promote and assist the speedy and complete subsidence of the precipitate. Heating the precipitate with its menstruum will often produce the desired effect; in other cases, as with chloride of silver, agitation may be had recourse to with advantage; lastly, in some instances reagents may be added, as alcohol added to water to induce complete precipitation of chloride of platinum and ammonium, chloride of lead, and sulphate of lime; or ammonia, to ensure the precipitation of phosphate of magnesia and ammonia. Again, a precipitate may sometimes be prevented from passing through a filter by modifying the menstruum: thus, the tendency of sulphate of baryta, when filtered from an aqueous solution, to pass through the filter, may be prevented in a great measure by the addition of chloride of ammonium.

Substances which have been precipitated from hot solutions are usually best filtered while hot, since hot fluids run through the filter more quickly than cold ones.

Lastly, the precipitate should be repeatedly washed with fresh quantities of the proper menstruum,—usually distilled water,—until there is no trace of a dissolved substance to be detected in the last rinsings.

Decantation.—The second method by which precipitates may be separated is by decantation: this will be found in many cases a very expeditious and accurate method of separation. The precipitate should be allowed to subside completely before pouring off the supernatant liquid, and should subsequently be washed repeatedly.

A far larger amount of water being required for washing precipitates separated by decantation than is the case with precipitates washed upon filters, it is necessary, where the former process is adopted, that the precipitates should be insoluble. For the same reason decantation is not ordinarily resorted to in cases where, besides the amount of the precipitated substance, we have to determine the amount of other constituents contained in the decanted fluids.

Distillation.—There are three particulars which require to be carefully attended to in the distillation of alcoholic liquids, including beer.

One of these is, to close completely the opening between the beak of the retort and the neck of the receiver: this is well effected by means of a perforated cork, by which the two vessels are joined, the junction being well secured by a lute of linseed meal made into a paste.

Another particular is to take care that all the alcohol has really passed over before suspending the distillation. Before this is fully accomplished it is generally necessary that three-fourths of the spirituous liquid should be distilled over; and even then it is advisable, where the strictest accuracy is desired, to distil over a fresh but small quantity of the liquid,—that which first passed over having been removed,—and to take its specific gravity.

The third point is to regulate exactly the temperature of the spirit to a fixed standard before proceeding to the determination of its specific gravity, by means of the specific gravity bottle.

Incineration.—There are two objects to be kept in view in the incineration of organic substances, the ashes of which are intended for analysis or the weight of which is required to be determined with accuracy.

These are, the complete destruction of the carbon, without alteration or decomposition of the salts composing the ash.

The combustion, therefore, while it is complete, must be effected at the lowest practicable temperature, that is, at a dull red heat. There are several ways in which these objects may be accomplished. It will be necessary only to notice one or two of the best and most convenient methods. One method is as follows: —

The organic substance, being properly dried at 212° F. and weighed, is to be charred in a platinum or Hessian crucible at a gentle red heat. The charred mass is then to be transferred to a shallow platinum dish; over this is to be placed a glass chimney supported on a triangular piece of platinum wire; the flame of a gas or spirit lamp is to be applied to the dish. The increased current of air caused by the chimney suffices to effect the complete incineration of most organic substances.

In a second method the muffle is employed.

The substance to be incinerated is placed on a platinum or porcelain dish or capsule; this is introduced into the muffle, which is gradually heated in the furnace. When the evolution of the empyreumatic products of combustion ceases, the heat should be increased, but not beyond a very faint redness, visible only in the dark. At this temperature, no salts except the carbonates — the carbonic acid being partially dissipated—are decomposed, and the carbon, which burns with a feeble incandescence, is destroyed in the course of a few hours.

When great accuracy is not required, the incineration may be conducted in a porcelain capsule, over an open fire or flame.

When the substance to be incinerated is too large for the muffle, it may be first charred, and its bulk thus reduced.

That the careful regulation of the temperature during incineration is a matter of much importance, is shown by the fact that when the heat is increased much beyond a dull redness, the metallic chlorides are in part volatilised, as may be also a portion of the phosphoric and sulphuric acids, of the phosphates and sulphates: besides, excessive heat causes the metallic chlorides and the phosphates of the alkalies to fuse; and the fused mass enclosing the carbon, greatly impedes its combustion.

Most of the salts and substances present in the ashes of plants were unquestionably constituents of the plants from which the ashes were procured. In regard to some others, it is uncertain whether they were originally present in the plant, or owe their formation to the incineration; while, with respect to others, it is certain that they owe their origin entirely to that process.

Thus the sulphates, and even the carbonates, may have been original constituents of the plants; or they may have been formed, and this they no doubt are to some extent, in the process of incineration by the destruction of salts with organic acids, and by the oxidation of the sulphur present in all plants.

The metallic sulphides are certainly formed by the action of the charcoal upon the sulphates, the supply of oxygen being limited.

It was formerly considered that the presence of carbonates in the ash of a plant not containing carbonates might invariably be regarded as a proof of the presence of salts with organic acids in the incinerated plant. It has been shown, however, that alkaline carbonates and pyrophosphates are formed when tribasic alkaline phosphates are ignited with a large excess of sugar, or with the carbon of sugar.

Reagents required for the Detection of Adulteration.

It had occurred to us to enumerate the reagents required for the detection of adulteration. These might have been arranged either under the names of the articles subjected to examination, the several purposes for which the reagents are employed being at the same time very briefly indicated; or they might have been classified under the heads of the different chemical substances employed in adulteration. On full consideration, however, it does not appear that any sufficient or great advantages would result from either of the proposed classifications of the reagents required; these will of course be specified in connection with the description of the means to be adopted for the discovery of the adulterations practised upon the various articles of food and medicine described in the course of the work.

The preceding observations relating to the chemical apparatus, preliminary chemical processes, and the reagents employed for the discovery of adulteration, are of course intended not for professed chemists, but rather for the information of students and beginners, who desire to become acquainted only with as much chemistry as will enable them to detect adulteration in articles of food and medicine. It is hoped that they will facilitate the labours of the inquirer, who has this object in view.

The special instructions, microscopical and chemical, necessary for the discovery of the adulterations to which the several articles of food and medicine examined are subject, will be found under the names of the articles themselves.

As, however, occasional doubts and difficulties may arise, and particularly as the student may desire to extend his investigations beyond the limits of this treatise, it would be well that he should provide himself with the English translations of Fresenius' works on chemical analysis, the one entitled "Elementary Instruction in Qualitative Chemical Analysis," and the other "A System of Instruction in Quantitative Chemical Analysis." These works abound in practical instruction of the first importance, and therefore are invaluable to the student of chemistry.

PART I.

FOOD AND ITS ADULTERATIONS.

On the Means pursued in procuring Samples for Analysis, and in arriving at the Results recorded in the present Work.

Before proceeding to describe the adulterations practised upon each of the more important articles of consumption, whether solids, liquids, or medicines, it may be premised that we shall chiefly describe those adulterations which, in the course of six years' continuous application to the subject, we have ourselves ascertained, on the strictest investigation, to be actually practised.

We may state also, briefly, the method pursued in order to arrive at the results about to be placed before the reader.

The method pursued to detect adulteration was as follows. A considerable number of samples of each article submitted to examination, were purchased in the ordinary way at shops of all descriptions, some of these being establishments of the first class, and others shops at which the general public obtained its goods. In many instances, all the shops of one kind in whole roads and streets were visited without exception in succession.

These purchases were made in the presence of witnesses,—we ourselves, for greater security, and knowing well the fearful responsibility which rested upon us, accompanying the purchasers on all occasions. Immediately that any article was purchased, the names of the purchasers were placed upon it, the date of the purchase, and the price paid for it. Subsequently each sample was subjected to careful microscopical and chemical examination, the results of the analysis being published from time to time in "The Lancet," together with the names and addresses of the merchants or traders from whom the purchases were made.

The publication of the several Reports, which for a long time came out almost weekly, extended over a period of four years. The last of our reports which appeared was published in "The Lancet" in December, 1854. Since that period we have been incessantly occupied with the subject, and have published two works on adulteration, as well as articles, the substance of which will be found recorded in the pages of this work, on the adulteration of Cones flour, sago and tapioca, annatto, cheese, honey, rum, brandy, wine, liquorice, colocynth, compound scammony powder, and other drugs.

The conclusions, then, at which we have arrived, are based, not upon the results of the examination of a single or even a few samples of any particular article, but upon the rigorous examination of an extended series of samples, these amounting, in the aggregate, to about 3000 specimens of all kinds.

Our readers will, we are assured, agree with us, that it was impossible to proceed in a more business-like or impartial manner than this, or to offer stronger guarantees of the accuracy of the results obtained.

We would now state that although the names of between two and three thousand traders have been thus published, the publication extending, as already stated, over a period of more than four years, in one case only were any legal proceedings resorted to, and even in this single instance the action was abandoned at an early date, without any acknowledgment being made of error having been committed. Pursuing such a system, and with such results, we would ask, is it possible that the conclusions arrived at could be otherwise than correct? On the contrary, is it not certain that, if mistakes had been made, they would have been quickly exposed, and Mr. Wakley the Editor of "The Lancet" and ourselves visited with the consequences, which would have been nothing short of utter ruin and disgrace.

Arrangement of Articles of Food.

Articles of food are divisible into solids and liquids. The solids may be further separated into those which are derived from either the vegetable or animal kingdom, and the liquids into natural and manufactured drinks.

As no particularly useful purpose would be served by following the above arrangement, we do not propose to confine ourselves to it, but will treat of the several articles rather in the order of their use at the breakfast or dinner table. By adopting this course, a tolerably natural arrangement will be secured. Thus the several natural and manufactured drinks, the condiments, &c., will follow in order.

The consideration of the articles consumed at breakfast brings us to the description of the adulterations of tea, coffee, chicory, cocoa, sugar, honey, milk, flour, bread, butter, lard, oatmeal, anchovies, potted meats, and fish.

Wherever practicable, the following course or order will be adopted in the treatment of each article.

First. Its chemical composition and peculiarities, general or microscopical structure, and its properties, will be described.

Second. Its adulterations.

Third. The methods, microscopical and chemical, employed for the discovery of its adulterations.

TEA, AND ITS ADULTERATIONS.

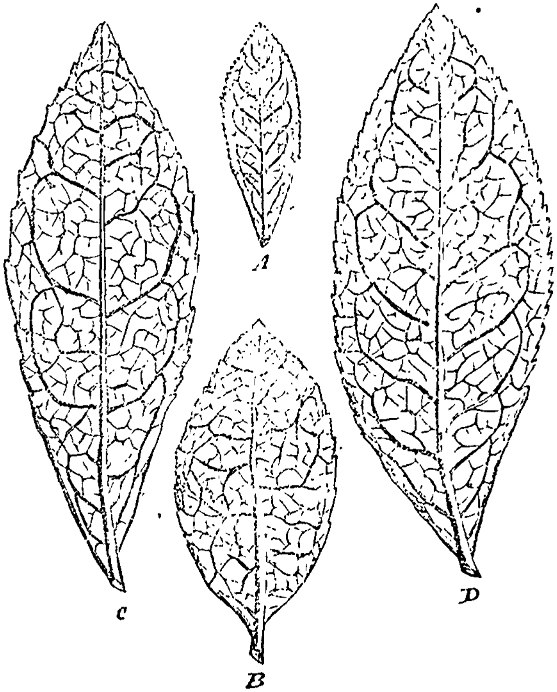
Growth and Preparation of Tea.

The tea-plant, *Thea Sinensis*, and of which *T. Bohea* and *T. viridis* are but varieties, is a hardy, evergreen, and leafy shrub, which attains the height of from three to six feet, and upwards; it belongs to the natural family *Columniferæ*, *Ternstromiaceæ* of Lindley, which includes the Camellias. It is generally propagated from seed; the seedlings are planted out in rows, three or four feet apart when a year old, and the plants come to maturity in from three to four years, yielding, in the course of the season, three, and, in some cases, four crops of leaves. The cropping is seldom continued beyond the tenth or twelfth year, when the old trees are dug up and replaced by seedlings.

The first gathering takes place very early in the spring, a second in the beginning of May, a third about the middle of June, and a fourth in August. The leaves of the first gathering are the most valuable, and from these, Pekoe tea, which consists of the young leaf-buds, as well as black teas of the highest quality, are prepared: those of the last gathering are large and old, and, consequently, inferior in flavour and value.

"It was after the year 600 that the use of tea became general in China, and early in the ninth century (810) it was introduced into Japan. To Europe it was not brought till about the beginning of the seventeenth century. Hot infusions of leaves had been already long familiar as drinks in European countries. Dried sage-leaves were much in use in England, and are even said to have been carried as an article of trade to China by the Dutch, to be there exchanged for the Chinese leaf, which has since almost entirely superseded them. A Russian embassy to China also brought back to Moscow some carefully packed green tea, which was received with great acceptance. And in the same century (1664) the English East India Company considered it as a rare gift to present the Queen of England with two pounds of tea."* — *Johnston.*

Fig. 6.



Leaves of the Tea-plant.

A, young leaf; *B*, leaf of black tea of medium size; *C*, ditto of larger growth; *D*, leaf of the green variety of the tea-plant.

The leaves vary considerably in size and form, according to age: the youngest leaves are narrow, convoluted, and downy; those next in age and size have their edges delicately serrated, with the venation scarcely perceptible; in those of medium and large sizes the venation is well marked, a series of characteristic loops being formed along each margin of the leaf, and the serrations are stronger and deeper, and placed at greater intervals.

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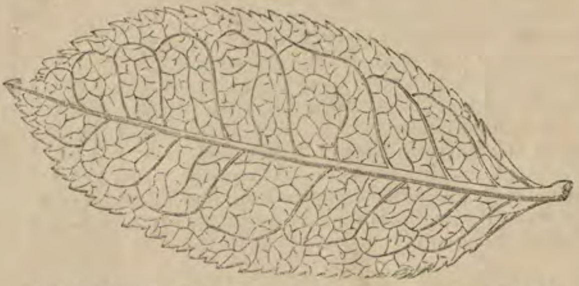
* The Plant, by Schleiden. Second Edition, p. 142.

Fig. 7.



Leaf of the *Assam* variety of the TEA-PLANT; the venation is the same as in the black and green varieties, but there is a slight difference in the serrations, which are alternately large and small — a difference which is probably not constant.

The principal varieties of black tea are Bohea, which is the commonest, and coarsest description, Congou, Souchong, Caper, and Padre Souchong, and Pekoe, which are of the highest quality, the last consisting of the very young and unexpanded leaves, and which, when clothed with down, constitute flowery Pekoe.

The principal varieties of green tea are Twankay, Hyson-skin, Young Hyson, Hyson, Imperial, and Gunpowder, which, in green tea, corresponds with flowery Pekoe in black. Imperial, Hyson, and Young Hyson, consist of the second and third gatherings, while the light and inferior leaves, separated from Hyson by a winnowing machine, constitute Hyson-skin, a variety in considerable demand amongst the Americans.

There is, according to most writers, but one species of tea-plant, from which the whole of the above, and many other varieties of tea, are obtained, the differences depending upon soil, climate, age of the leaves, and mode of preparation.

The plants from which black teas are prepared are grown chiefly on the slopes of hills and ledges of mountains *, while the green tea-shrubs are cultivated in manured soils. Upon this circumstance many of the differences between the two varieties depend.

Other differences are occasioned by the processes adopted in the preparation and roasting of the leaves. Thus, while black tea is first roasted in a shallow iron vessel, called a *kuo*, and secondly in sieves, over a bright charcoal fire, green tea does not undergo the second method of roasting, but only the first—that in the *kuo*.

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* There is a range called the Bohea Mountains, from which Bohea tea takes its name.

The leaves of black tea undergo a species of fermentation before their final drying, and it is this which occasions them to assume so dark a colour: those of green tea do not undergo this preliminary fermentation, being dried while in a fresher state; but the leaves, as thus prepared, are of a yellowish or olive green tint, very unlike the colour of the green teas imported into this country.

An important part of the manufacture of tea consists in the *rolling* the leaves, so as to impart to them their characteristic twisted shape. This is effected by subjecting the leaves to pressure, and rolling by the hands in a particular manner. The first effect of the application of heat to the leaves in the *kuo*, is to render them soft and flaccid; when in this state, they are removed from the vessel, and submitted to the first rolling — an operation which, after the renewed action of the *kuo* on each occasion, is three or four times repeated, with superior teas, before the process is considered to be complete.

Scenting of Tea.

There are several kinds of scented tea: those with which we are best acquainted in this country are scented Caper or Chulan, and scented orange Pekoe. The scent is communicated to these teas by means of the Chulan flower, *Chloranthus inconspicuus*. The flowers of other plants are, however, used for the purpose; amongst these may be named those of *Olea fragrans*, *Gardenia florida*, and *Jasminum Sambac.*

The process pursued varies in different cases. Sometimes the fresh flowers are strewn between successive layers of tea; the tea and flowers are then roasted until the flowers become crisp, when they are sifted out. In other cases the flowers are dried, powdered, and then sprinkled over the tea. For further particulars respecting the scenting of tea, the reader is referred to Mr. Ball's "Account of the Cultivation and Manufacture of Tea in China."

Analysis of Tea.

The infusion made from tea contains *gum*, *glucose*, or saccharine matter, a large quantity of *tannin*, *volatile oil*, and a peculiar nitrogenised principle called *theine;* this is identical with *caffeine*, and upon its presence many of the properties of tea depend.

The amounts of gum and tannin contained in a given sample of tea afford data by which its quality may, to some extent, be determined.

The per-centage of these substances may be obtained in the following manner: One hundred grains of tea, dried by means of a water-bath, are to be boiled for some time in about a quart of distilled water; this dissolves out the gum and tannin, but does not affect the lignin, which, re-dried in the same way at a temperature of 212° Fahr., and weighed, gives the amount of that substance present in the hundred grains, and shows by the loss of weight, the combined quantities of the gum and tannin. The decoction is now to be evaporated, and the residuum treated with alcohol; this will take up the tannin and colouring matter, but leave the gum, the weight of which being ascertained, after drying, gives the per-centage of tannin.

Should it be desired to estimate the quantity of tannin separately, this may be effected either by evaporating the alcoholic solution and drying the residue in the ordinary way, or else by the precipitation of the tannin from the decoction, by a solution of gelatine. The precipitate being washed aud dried at a steam heat, indicates the quantity of tannin, 100 grains of the precipitate being equal to 40 grains of tannin.

The determination of the amount of *nitrogen* in any tea should form part of a rigid analysis; for this purpose, 100 grains, dried in a water-bath until it ceases to lose weight, is to be incinerated with soda-lime, and its contents in nitrogen then ascertained.

While the average amount of nitrogen in tea exceeds five per cent., that in sloe, hawthorn, and elder leaves is seldom over three per cent., and in the first two is nearly always much under this quantity.

The following are the methods of proceeding adopted by different chemists for obtaining the active principle of tea, *theine*, and for estimating its amount:—

Mulder obtains it from tea by heating the evaporated extract by hot water, with calcined magnesia, filtering the mixture, evaporating to dryness the liquor which passes through, and digesting the residuum with ether. This solution being distilled, the ether of course passes over, and the theine remains. This principle may be extracted in the same way from raw ground coffee.

Dr. Stenhouse obtains theine by adding acetate of lead to a decoction of tea, evaporating the filtered liquid to a dry extract, and exposing this extract to a subliming heat in a shallow iron pan, whose mouth is covered with porous paper, luted round the edges as a filter to the vapour, and surmounted with a cap of compact paper, as the receiver. According to this method, Dr. Stenhouse obtained only 1·37 per cent. of theine.

M. Peligot, remembering that the quantity of nitrogen contained in tea-leaves frequently amounted to 6 per cent., was hence led to believe that much more theine existed in them than had hitherto been separated, and he adopted the following improved method of extraction:—

To the hot infusion of tea, subacetate of lead and then ammonia were added; the liquid was filtered, and the lead separated by means of sulphuretted hydrogen; after a second filtration, the clear liquid, being evaporated at a gentle heat, afforded, on cooling, an abundant crop of crystals. By re-evaporation of the mother liquid more crystals were procured, amounting altogether to from 5 to 6 per cent.

According to *Mulder's analysis*, 100 parts of tea consist of—

	Green.	Black.
Essential oil (to which the flavour is due)	0·79	0·60
Chlorophylle	2·22	1·84
Wax	0·28	—
Resin	2·22	3·64
Gum	8·56	7·28
Tannin	17·80	12·88
Theine	0·43	0·46
Extractive	22·30	19·88
Do., dark-coloured	—	1·48
Colourable matter, separable by hydrochloric acid	23·60	19·12
Albumen	3·00	2·80
Vegetable fibre	17·08	28·32
Ash	5·56	5·24
	100·0	100·0

The *theine* is obviously much underrated in Mulder's analyses. According to Stenhouse, the teas of commerce contain, on an average, about 2 per cent of theine.

Theine, when pure, crystallises in fine needles, glossy, like white silk; the crystals lose, at 212°, 8 per cent. of their weight, or two atoms of water of crystallisation; they are bitter but have no smell; they melt at 550° F., and sublime at 543° without decomposing; dried at 350°, they dissolve in 98 parts of cold water, 97 of alcohol, and 194 parts of ether. Theine is a feeble base, and is precipitable by tannin alone from its solutions.

The *volatile oil* is not present in fresh tea, but is developed in the course of drying and roasting; it is to it that the aroma and flavour of tea are mainly due: 100 pounds of tea distilled with water yield about 1 pound of this oil.

Structure of the Tea-leaf.

The characters of the tea-leaf visible to the naked eye, such as its venation and the crenation of the edges, have already been described.

Examined with the microscope, the following is ascertained to be its general structure. It is made of epidermic cells, stomata, parenchymatous cells, and hairs.

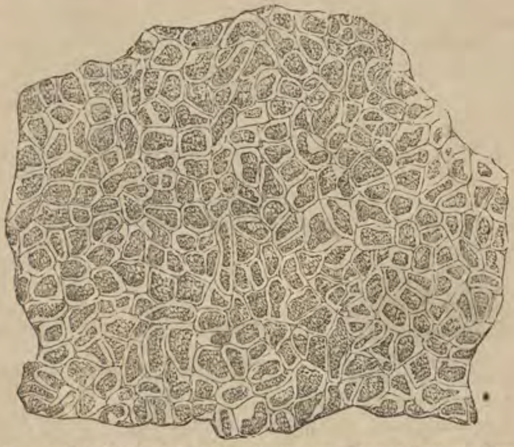
The *epidermic cells* vary much in size, according to the age and size of the leaf: in the leaf of medium age and size the cells are small and slightly angular only, while in the hard and old leaf they are very much larger, more angular, and the walls of the cells are more distinctly visible.

The *stomata* are confined principally to the under surface of the leaf, they are rather numerous, small, and are formed of two reniform cells, which leave a very decided aperture between them. The epidermic cells around the stomata are much elongated and curved like the cells of the stomata themselves.

The *hairs* are also confined to the under surface of the leaf: in the very young leaf they are very numerous, but in those of middle age they are much less abundant, and indeed in some cases are nearly altogether wanting; they are short, and, when not broken, pointed and undivided.

The cells forming the substance or *parenchyma* of the leaf resemble those of most other leaves, and do not present anything remarkable.

Fig. 8.



Upper surface of TEA-LEAF, showing its structure. Magnified 350 diameters.

This and the next figure represent the tea-leaf as it appears under the microscope as met with in most black teas.

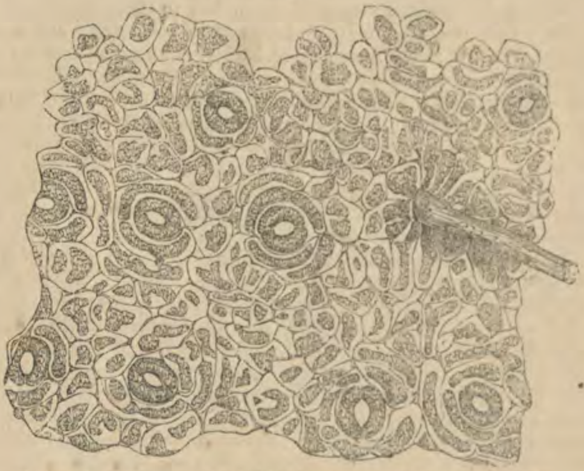
Properties of Tea.

Lo-Yu, a learned Chinese, who lived in the dynasty of Tang, A.D. 618 to 906, gives the following agreeable account of the qualities and effects of the infusion of the leaves of the tea-plant:—

"It tempers the spirits, and harmonises the mind; dispels lassitude, and relieves fatigue; awakens thought, and prevents drowsiness; lightens or refreshes the body, and clears the perceptive faculties."

In Pereira's "Materia Medica" we find the following remarks relating to the properties of tea:—"Its astringency is proved by its chemical properties. Another quality possessed, especially by green tea, is that of diminishing the tendency to sleep. Tea appears to possess a sedative influence with regard to the vascular system. Strong green tea, taken in large quantities, is capable, in some constitutions, of producing most distressing feelings, and of operating as a narcotic."

Fig. 9.



Under surface of TEA-LEAF, showing the stomata and cells of this portion of the leaf, as well as a part of one of the hairs by which this surface is clothed. Magnified 350 diameters.

Professor Johnston gives the following description of the properties of tea: "It exhilarates without sensibly intoxicating. It excites the brain to increased activity, and produces wakefulness. Hence its usefulness to hard students, to those who have vigils to keep, and to persons who labour much with the head. It soothes, on the contrary, and stills the vascular system; and hence its use in inflammatory diseases, and as a cure for headache. Green tea, when taken strong, acts very powerfully upon some constitutions, producing nervous tremblings and other distressing symptoms, acting as a narcotic, and, in inferior animals, even producing paralysis. Its exciting effect upon the nerves makes it useful in counteracting the effects of opium and of fermented liquors, and the stupor sometimes induced by fever."*

The properties and effects of tea are due to the conjoined action of at least three active chemical constituents, namely, the *volatile oil*, *theine*, and *tannic acid.*

The special action of the volatile oil has not yet been scientifically determined; but in Professor Johnston's "Chemistry" we meet with the following remarks relative to its properties:—"That it does exert a powerful, and most likely a narcotic, influence is rendered probable by many known facts. Among them I mention the headaches and giddinesses to which tea-tasters are subject; the attacks of paralysis to which, after a few years, those who are employed in packing and unpacking chests of tea are found to be liable; and the circumstance, already alluded to, that in China tea is rarely used till it is a year old, because of the peculiar intoxicating property which new tea possesses. The effect of this keeping upon tea must be chiefly to allow a portion of the volatile ingredients of the leaf to escape. And lastly, that there is a powerful virtue in this oil is rendered probable by the fact that the similar oil of coffee has been found by experiment to possess narcotic properties."

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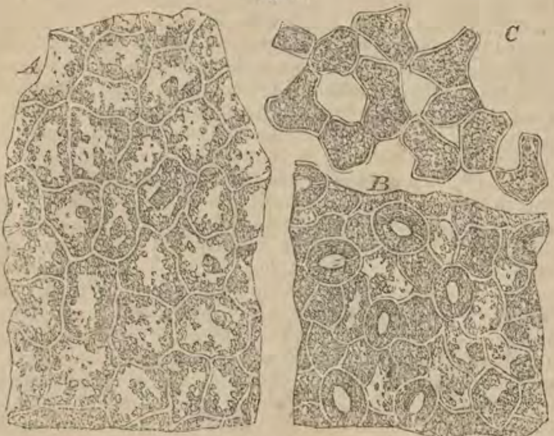
* Chemistry of Common Life. Blackwood.

Fig. 10.



TEA-LEAF.

A, upper surface of fully-developed leaf, representing the cells of which it is constituted; *B*, under surface, showing its cells and stomata; *C*, chlorophylle cells.

The precise operation of the second active constituent of tea—*theine*—has been determined by direct experiment. In the quantity in which it is daily consumed by most tea-drinkers, that is, some four or five grains,—a quantity ordinarily present in about half an ounce of good tea,—it has been found to diminish the waste of tissue, the necessity for food to repair the waste being lessened in an equal proportion: one of the effects of tea is, therefore, to save food.

If as much as eight or ten grains of theine be taken daily,—a quantity present in about one ounce of tea of good quality,—it gives rise to the following symptoms: the pulse is rendered more frequent, the action of the heart stronger, trembling ensues, and there is a perpetual inclination to micturation. "At the same time, the imagination is excited; and after awhile the thoughts wander, visions begin to be seen, and a peculiar state of intoxication comes on. All these symptoms are followed by, and pass off in, deep sleep." It is evident, therefore, that the effects of strong tea are attributable in a great measure to the over-dose of theine introduced through it into the stomach.

The third active principle of tea is the tannin or tannic acid: it is this which imparts to tea its astringent taste, and which causes it to exert a slightly constipating effect upon the bowels. It is the more completely extracted the longer the tea is infused.

A fourth not unimportant constituent of the tea-leaf is gluten, which forms no less than one-fourth of the weight of the dried leaves. As tea is generally consumed in this country, the benefit of this substance is for the most part lost to the system, it not being dissolved by the hot water, but remaining behind in the leaves, with which it is usually thrown away. On this account the use of soda has been recommended, this dissolving a larger proportion of the gluten. In some countries the tea-leaves, either whole or in powder, from which the infusion has been made, are themselves eaten; and in this way the whole of the beneficial properties of tea are secured.

"The wealthy Chinese simply infuse the leaves in an elegant porcelain cup, which has a cover of the same material; the leaves sink to the bottom of the cup, and generally remain there without inconvenience, though occasionally some may float or rise to the surface. To prevent this inconvenience, sometimes a thin piece of silver, of filagree, or open work, is placed immediately on them. Where economy is necessary to be studied, the teapot is used. The wealthy Japanese continue the ancient mode of grinding the leaves to powder; and after infusion in a cup, 'it is whipped with a split bamboo, or denticulated instrument, till it creams, when they drink both the infusion and powder, as coffee is used in many parts of Asia.'" *

In China, as appears from the following extract, tea is the common beverage of the people. The late Sir George Staunton informs us "that tea, like beer in England, is sold in public-houses in every town, and along public roads, and the banks of rivers and canals, nor is it unusual for the burdened and weary traveller to lay down his load, refresh himself with a cup of warm tea, and then pursue his journey." †

The Adulteration of Tea.

Much skill and ingenuity are displayed, as we shall shortly perceive, both at home and in China, in the adulteration of tea.

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* Ball, on the Cultivation and Manufacture of Tea, p. 15.

† Lord Macartney's Embassy to Pekin, vol. ii. p. 96.

The principal adulterations of tea are the work of the Chinese themselves; but other adulterations are performed nearer home, by, in fact, British fabricators of spurious tea, both black and green. Those adulterations may be described in the first place which are of Chinese origin.

The *Souchongs* and *Congous* which form the great bulk of the black tea consumed in this country are rarely adulterated.

There are, however, varieties of black tea imported into this country from China which are never otherwise than adulterated; these are the *black Gunpowders Capers* or *Chulans*, and *scented orange Pekoe.*

Adulterations practised by the Chinese.

The adulterations practised with tea by the Chinese are of three very distinct kinds: one consists in the intermixture with genuine tea of leaves other than those of the tea-plant; a second is the manufacture of spurious articles denominated LIE TEA; while the third kind of adulteration consists in glazing, painting, or artificially colouring the surface of the leaves with various pigmentary substances.

Adulteration with Foreign Leaves.

In reference to the use of leaves other than those of the tea-plant the evidence of Dr. Dickson may be quoted, who states: "The Chinese annually dry many millions of pounds of the leaves of different plants to mingle with the genuine, as those of the ash, plum, &c.; so that all spurious leaves found in parcels of bad tea must not be supposed to be introduced into them by dealers in this county. While the tea-trade was entirely in the hands of the East India Company, few of these adulterated teas where shipped for this country, as experienced and competent inspectors were kept at Canton to prevent the exportation of such in the Company's ships; but since the trade has been opened, all kinds find a ready outlet; and as the demand often exceeds the supply, a manufactured article is furnished to the rival crews." *

Notwithstanding, however, the occasional use of foreign leaves, we can state, from the careful examination of a large number of samples, that the great bulk of the tea imported, especially the black tea, is but little affected by this adulteration. We have, however, on several occasions, met with foreign leaves and paddy-husk in some of the inferior descriptions of green tea, and in samples of the article to be described hereafter, manufactured by the Chinese, and denominated Lie tea.

The first tea in which we discovered foreign leaves was a sample of Gunpowder (Woping tea). Subsequently four different samples of tea of low quality, as imported into this country from China, were subjected to microscopic examination, and were all found to be adulterated with foreign leaves.

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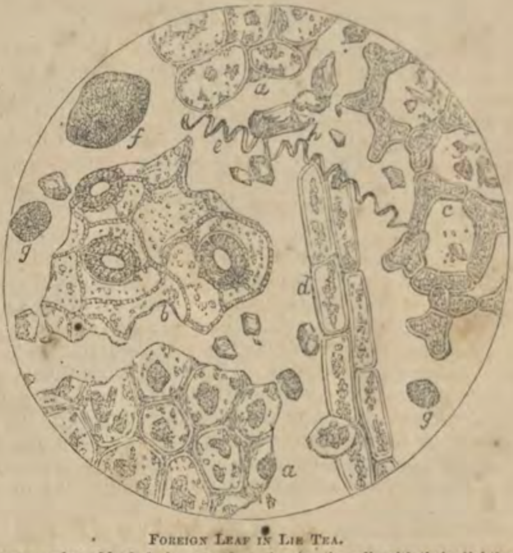
* Article "Tea," in Penny Cyclopædia.

In a sample of Gunpowder fragments of two kinds of foreign leaves were detected. The tea in question consisted in part of leaves, and partly of Lie tea. Now these foreign leaves formed not only the greater portion of the loose leaves, but also entered largely into the composition of the little masses of which Lie tea is constituted, scarcely a particle of tea-leaf itself having been observed in the sample.

The structure of two of these leaves is shown in the two following figures.

Fig. 11.



FOREIGN LEAF IN LIE TEA.

a, upper surface of leaf; *b*. lower surface, showing the cells with their slightly-beaded margins, of which it is composed; *c*. chlorophylle cells, so disposed as to form very large areolæ; *d*, elongated cells found on upper surface of the leaf in the course of the veins; *c*. spiral vessel; *f*, cell of turmeric; *g*, fragment of Prussian blue; *h*, particles of the white powder, probably *China Clay*.

A sample of "*Lie tea*," admixed with a few small fragments of leaves, consisting principally of portions of the leaf, much broken up, is represented in *fig*. 12.

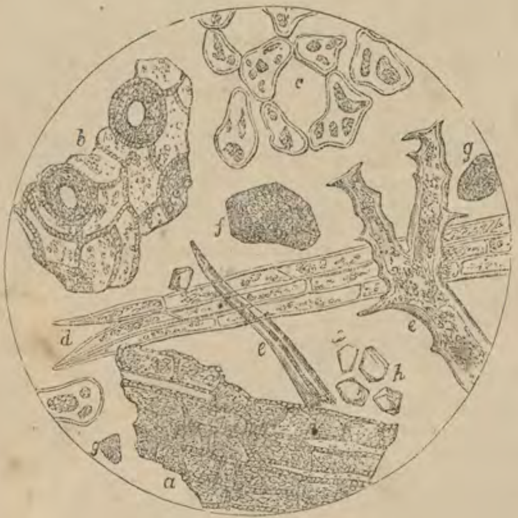
In a sample of *Twankay*, in addition to those of tea, the leaves of three other plants were detected, two of which we identified, the one was *Camellia Sasanqua*, the other a kind of *plum:* they are represented in *figs*. 13. and 14.

A second sample of "*Twankay*" was ascertained to consist of tea mixed with paddy-husk, portions of seed-vessels, and other substances: the leaves were of a coarse description, and wanted the peculiar twist characteristic of the more carefully prepared kinds of tea.

The leaves of *Chloranthus inconspicuus*, as well as of *Camellia Sasanqua*, have been known to be employed in the adulteration of tea, and they differ from tea-leaves chiefly in their venation. *Fig.* 15.

The second kind of adulteration consists in the manufacture of articles made up in imitation of tea, as the different varieties of *Lie tea.*

Fig. 12.



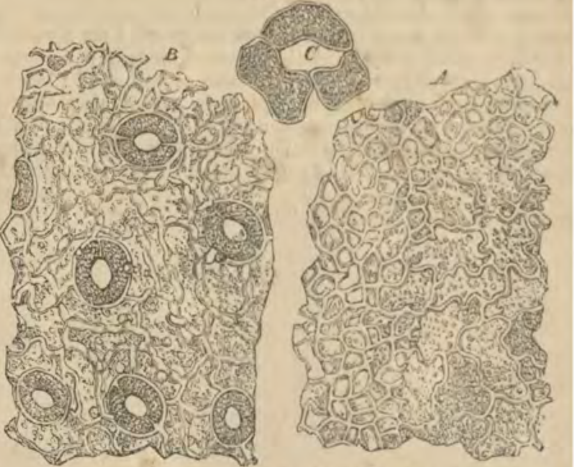
FOREIGN LEAF IN LIE TEA.

a, upper surface of leaf; *b*, lower surface; *c*, chlorophylle cells; *d*, elongated cells; *e*, portion of one of the branched and spinous hairs situated on the under surface of the leaf; *f*, cell of turmeric; *g*, fragment of Prussian blue; *h*, particles of the *white powder.*

Adulteration with Lie Tea.

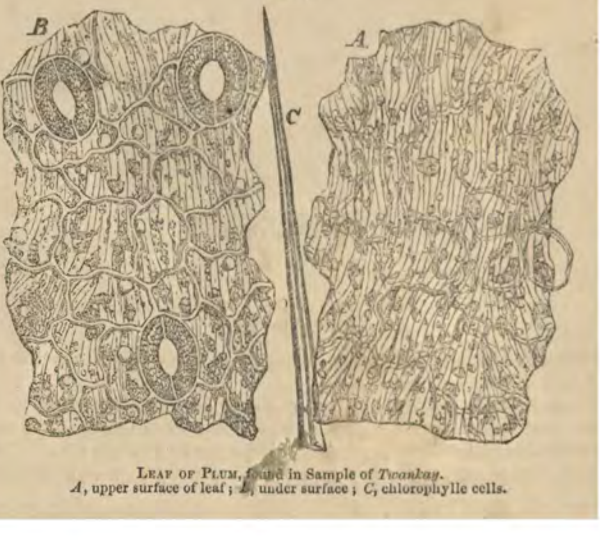
Now Lie tea is so called because it is a spurious article, and not tea at all: it consists of the dust of tea-leaves, sometimes of foreign leaves, and sand made up by means of starch or gum into little masses, which are afterwards painted and coloured so as to resemble either black or green Gunpowder. The skill exhibited in the fabrication of this spurious article is very great, and we have met with at least a

Fig. 13.



LEAF OF CAMELLIA SASANQUA, found in Sample of *Twankay*.
A, upper surface of leaf, showing the cells of which it is composed; *B*, under surface, exhibiting its cells and stomata; *C*, chlorophylle cells.

Fig. 14.



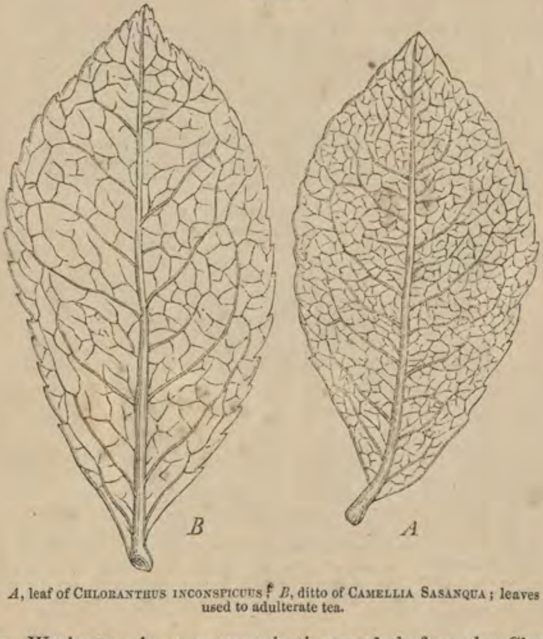
LEAF OF PLUM, found in Sample of *Twankay*.
A, upper surface of leaf; *B*, under surface; *C*, chlorophylle cells.

dozen varieties of it, differing from each other in the size and colouring of the little masses.

This article, although the chests containing it are branded with the words "Lie tea," was at a recent period extensively imported into this country, and of course found purchasers.

It is expressly manufactured for adulteration, and it is largely employed for this purpose by the Chinese themselves, who mix it with the different Gunpowder teas, black and green; which are so far genuine that they contain no other leaf than that of tea, although they are artificially coloured. Gunpowder teas, *even now*, are frequently met with containing various proportions of Lie tea.

Fig. 15.

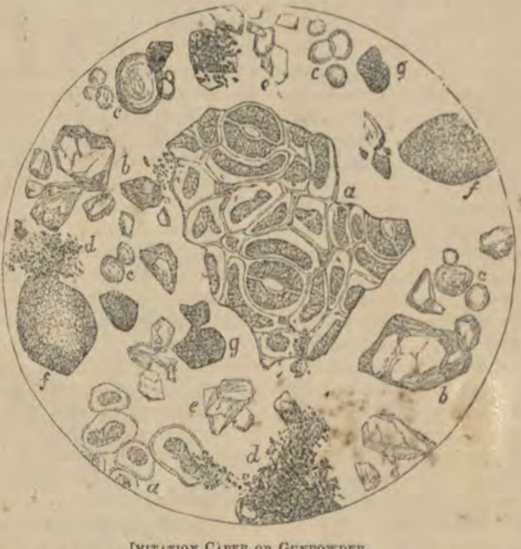


A, leaf of CHLORANTHUS INCONSPICUUS; *B*, ditto of CAMELLIA SASANQUA; leaves used to adulterate tea.

Mr. Warington, in a communication read before the Chemical Society of London, May, 1851, states: —

"On inquiry, I have learnt that about 750,000 lbs. weight of these teas have been imported into this country within the last eighteen months, their introduction being quite of modern origin; and I understand that attempts have been made to get them passed through the customs as *manufactured goods*, and not as teas; a title which they certainly richly merit, although it must be evident, from a moment's consideration, that the revenue would doubtless be defrauded, inasmuch as the consumer would have to buy them as teas from the dealer. It is to be feared, however, that a market for them is found elsewhere. The Chinese, it appears, would not sell them except as teas, and have the candour to specify them as *Lie* teas; and if they are mixed with other teas of low quality, the Chinese merchant gives a certificate, stating the proportion of the *Lie tea* present with the genuine leaf. This manufacture and mixing is evidently practised to meet the price of the English merchant. In the case of the above samples, the black is called by the Chinese, *Lie Flower Caper;* the green, *Lie Gunpowder;* the average value is from 8*d.* to 1*s.* per lb. The brokers have adopted the curious terms *gum and dust*, as applied to these Lie teas or their mixtures, a cognomen which at first I had some difficulty in understanding, from the rapid manner in which the first two words were run together."

Fig. 16.



IMITATION CAPER OR GUNPOWDER.

a a, fragments of the *tea-leaf* or *tea-dust; b b*, particles of *sand; c c, starch corpuscles; d d*, groups of granules of *black-lead; e e*, particles of *mica-like substance; f f*, cells of *turmeric; g g*, fragments of *indigo*. Magnified 350 diameters.

Mr. Ripley, tea broker, in evidence before the Parliamentary Committee, states that the importation of *Lie tea* in 1847 amounted to about 100,000 lbs., after which it increased about threefold, and eventually it became as large as 400,000 or 500,000 lbs.

Artificial Colouration and Adulteration of Tea.

The third principal kind of adulteration to which tea is liable consists in the glazing, painting, or artificial colouration of the leaves. This practice is had recourse to for the purpose of improving, as some consider, the appearance of certain descriptions of tea, especially the inferior kinds, and for the better concealment of some of its adulterations, as where foreign leaves are used, and to disguise more effectually the nature of Lie tea.

The substance employed in the glazing of the varieties of black tea known as scented Caper or black Gunpowder, orange Pekoe and the black variety of Lie tea, is one with which housemaids are particularly familiar, viz. graphite, plumbago, or black-lead. The teas coated with this substance present a peculiarly smooth and glossy appearance.

Occasionally small quantities of Prussian blue or indigo, turmeric, China clay, or some other yellow and white powders, are used, as well as the black-lead, in order to impart a somewhat different appearance to Chulan and black Lie tea.

But it is with green tea that the practice of artificially colouring the leaves is carried to the greatest extent. The varieties of green tea imported into this country from China are Twankay, Hyson-skin, young Hyson, Hyson, Imperial, and Gunpowder. Now the colour of the whole of these teas, without a single exception, is artificial, and caused by the adherence to the leaves of various colouring matters.

The usual colouring matters employed are ferrocyanide of iron or Prussian blue, turmeric, and China clay; these are mixed in various proportions, so as to produce different shades of blue and green; the surface of the leaves being moistened, they are then agitated with the mixtures until they become faced or glazed, as it is termed.

Occasionally other substances are employed by the Chinese, as indigo and sulphate of lime, or gypsum. In proof that it has long been the practice frequently to colour green tea artificially, we have the evidence of various travellers; but the most conclusive and complete evidence, both as to the extent of the practice and the nature of the ingredients used, has been supplied by means of the microscope.

Amongst the writers who have noticed the subject of the artificial colouration of tea may be mentioned Dr. Horsfield, Dr. Royle, Mr. Davis, Mr. Bruce, Mr. Ball, Mr. Fortune, and Mr. Warington.

In Dr. Horsfield's translation of a Dutch work on the subject of the cultivation of tea in Java, the following dialogue occurs: —

" *Visitor.* — Is it indeed the case that tea is so much adulterated in *China?*

"*Superintendent.*—Unquestionably, but not in the interior provinces, for there exist rigid laws against the adulteration of tea; and all teas, as they come out of the plantations, are examined on the part of the government, to determine whether they are genuine; but in Canton, which is the emporium of teas, and especially at Honân, many sorts, indeed most teas, are greatly adulterated, and that with ingredients injurious to health, especially if too much of these ingredients be added. This is especially the case with the *green* tea, in order to improve the colour, and in this manner to add to the value of the teas in the eyes of the common consumers.

"*Visitor.* — Are these ingredients known?

"*Superintendent.* — Most of them are certainly known; they have been communicated to government (the Dutch government), while at the same time the privilege has been requested that they might not be employed here; and although this occasions loss, the request has been granted, and it has been ordered by government, that not the least admixture should take place, either to improve the colour or taste of the tea, even in such cases where this might be desirable." *

Dr. Royle writes †, "The Chinese in the neighbourhood of Canton, are able to prepare a tea which can be coloured and made up to imitate various qualities of green tea, and large quantities are thus yearly made up.

"Young Hyson," states Mr. Davis ‡, "until spoiled by the large demand of the Americans, was a delicate genuine leaf, and as it could not be fairly produced in any large quantities, the call for it on the part of the Americans was answered by cutting up and sifting *other* green teas through sieves of a certain size, and as the Company's inspectors detected the imposture, it formed no portion of their London importation. But the abuse became still worse of late, for the coarsest *black* tea-leaves have been cut up, and then *coloured* with a preparation resembling the hue of green teas."

"But this was nothing," continues Mr. Davis, "in comparison with the effrontery which the Chinese displayed in carrying on an extensive manufacture of *green teas* from *damaged black leaves*, at a village or suburb called Honân.

"The remission of the tea-duties in the United States occasioned, in the years 1832 and 1833, a demand for green teas at Canton, which could not be supplied by arrivals from the provinces. The Americans, however, were obliged to sail with cargoes of green teas within the favourable season; they were determined to have the teas, and the Chinese were determined that they should be supplied. Certain rumours being afloat concerning the manufacture of green tea from old black leaves, the writer of this became curious to ascertain the truth, and with some difficulty persuaded a Hong merchant to conduct him, accompanied by one of the inspectors, to the place where the operations were carried on. Entering one of these laboratories of fictitious Hyson, the parties were witnesses to a strange scene. The damaged black tea-leaves, after being dried, were transferred to a cast-iron pan, placed over a furnace, and stirred rapidly with the hand, a small quantity of turmeric, in powder, having been previously introduced. This gives the leaves a yellowish or orange tinge, but they were still to be made green. For this purpose some lumps of fine blue were produced, together with a substance in powder, which from the names given to them by workmen, as well as their appearance, were known at once to be *Prussian blue* and gypsum. These were triturated finely together with a small pestle, in such proportions as reduced the dark colour of the blue to a light shade; and a quantity equal to a teaspoonful of the powder being added to the yellowish leaves, these were stirred as before over the fire until the tea had taken the fine bloom colour of Hyson, with very much the *same scent.* To prevent all possibility of error regarding the substances employed, samples of them were carried away from the place. The Chinese seemed quite conscious of the real character of the occupation in which they were engaged; for on attempting to enter several other places where the same process was going on, the doors were speedily closed upon the party; indeed, had it not been for the influence of the Hongist who conducted them, there would have been little chance of seeing as much as they did."

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* Essay on the Cultivation and Manufacture of Tea in Java. Translated from the Dutch.

† Tea, Medicinal and Dietetical. — *Penny Cyclopædia.*

‡ Davis' Chinese, vol. ii. p. 464.

Mr. Bruce states, that "in the last operation of colouring the green teas, a mixture of sulphate of lime and indigo, very finely pulverised, and sifted through fine muslin, in the proportion of three of the former to one of the latter, is added; to a pan of tea, containing seven pounds, about half a teaspoonful of this mixture is put, and rubbed and rolled along with the tea in the pan for about an hour. The above mixture is merely to give it a uniform colour and appearance. The indigo gives it the colour, and the sulphate of lime fixes it." *

In Mr. Ball's valuable work, already quoted, we meet with the following observations relating to the artificial or factitious colouring of certain descriptions of green tea: —

"The latter — viz., The Singlo Hysons and 'Superior Twankay' — have frequently a glazed appearance, as also the Singlo Gunpowders, which I imagine may formerly have arisen more from the quality of the leaf than from any factitious means employed to produce the colour. Still in some cases a small quantity of colouring matter may have been used. It has also been shown that the tea made from the Honân leaves had a glazed appearance. It nevertheless is true, that when the leaf is deficient in the requisite colour, the Chinese do not hesitate to employ colouring matter to improve it.

"Again, so far as the characteristic colour of green tea is concerned, the mode of producing it has been explained and established. If factitious means are now generally or almost universally adopted to imitate or increase the effect of the natural colour, it may be considered as a great and novel abuse, and ought to be discouraged by brokers and dealers. It is injurious to flavour. Whether the Chinese do employ colouring matter or not for the teas they use themselves, there can be no doubt that the bulk of the Hyson teas of the present day, and indeed all descriptions of green tea, are now glazed to a degree which would have insured their rejection by the East India Company."

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* Report on the Manufacture of Tea.

Tien Hing, described by Mr. Ball as a respectable tea merchant and factor, in his account of the method of making Twankay tea, writes,—

"In the seventh or eighth moon (August and September) each parcel is compared together, when such as correspond in quality and colour are formed into one pile, roasted three *che hiang*, the dust sifted, and the tea packed (hot) in chests for Canton. The leaves of the second gatherings have no juices, are light, thin, and of no substance; the infusion weak and tasteless, the colour red, and the infused leaves black. If very common and old, colouring matter is then used. The factitious colour is produced by a mixture of Ma Ky Hoey, Tien Hoa (indigo), and She Kao powder (calcined foliated gypsum). The smallest quantity put into the *kuo* at one time is one or two teaspoonfuls, and the largest three or four. The colour then changes to a light blue. The fire must be made of charcoal, and much attention paid to the roasting. Now, if the chests be not in readiness, it is to be feared the tea may be mixed with false leaves, the smell thereby injured, and the tea rendered unhealthy. But I must refer you to abler men than myself for instruction on that point. I have no information on such practices."

Mr. Ball then goes on to state "that most other merchants or factors agree with the foregoing account of the Twankay teas, and particularly as to the circumstance of their being partly glazed or coloured by artificial means, and also that some chops are mixed with leaves that are not tea-leaves." *

Another writer, Mr. Fortune, who also saw the colouring of tea performed in China, and who has described the process minutely, states that during one part of the operation the hands of the workmen are quite blue. "I could not help thinking," he remarks, "that if any green-tea drinkers had been present during the operation, their taste would have been corrected and improved.

"One day an English gentleman in Shanhae being in conversation with some Chinese from the green-tea country, asked them what reasons they had for dyeing the tea, and whether it would not be better without undergoing this process. They acknowledged that tea was much better when prepared without having any such ingredients mixed with it, and that they never drank dyed teas themselves; but remarked that as foreigners seemed to prefer having a mixture of

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* On the Cultivation and Manufacture of Tea.

Prussian blue and gypsum with their tea to make it look uniform and pretty, and as these ingredients were cheap enough, the Chinese had no objection to supply them, especially as such teas always fetched a higher price." *

Mr. Warington communicated a valuable paper, on the artificial colouration of tea, to the Chemical Society, in 1844. He writes,—

"In examining lately some samples of tea which had been seized from their being supposed to be spurious, my attention was arrested by the varied tints which the sample of green tea exhibited, extending from a dull olive to a bright greenish-blue colour. On submitting this to the scrutinising test of examination by the microscope with a magnifying power of one hundred times linear, the object being illuminated by reflected light, the cause of this variation of colour was immediately rendered apparent, for it was found that the curled leaves were entirely covered with a white powder, having in places a slightly glistening aspect, and these were interspersed with small granules of a bright blue colour, and others of an orange tint; in the folded and consequently more protected parts of the curled leaves these were more distinctly visible."

Mr. Warington subsequently examined several other samples of green tea as imported, the whole of which he found to be artificially coloured.

Lastly, in the Museum of Economic Botany attached to the Kew Botanical Gardens, there are some specimens of tea dyes, used by the Chinese to colour their green teas. These were procured by Mr. Berthold Seeman from one of the tea factories at Canton. They consist of Prussian blue, turmeric, chalk, and either China clay or gypsum.†

It appears, therefore, from these examinations that the green teas, as imported, are very frequently faced or coloured artificially. Our own investigations, embracing a great variety of samples, show that nearly *the whole of the green teas imported into this country, as retailed in the shops, are thus coloured;* and that when not thus coloured, there is but little in appearance or colour to distinguish green from black tea; the chief difference in colour being that the former is sometimes inclined to olive.

In the Museum at Kew will be found a series of samples of black and green tea, also of several different varieties of Lie tea, all artificially coloured, being some of those met with by ourselves in the course of our investigations into the subject of the adulteration of tea.

It is a question deserving consideration, how far the colouring matters employed explain the injurious effects which result in some cases from the use of green tea. The Chinese themselves never make use of these glazed teas — a rather significant fact.

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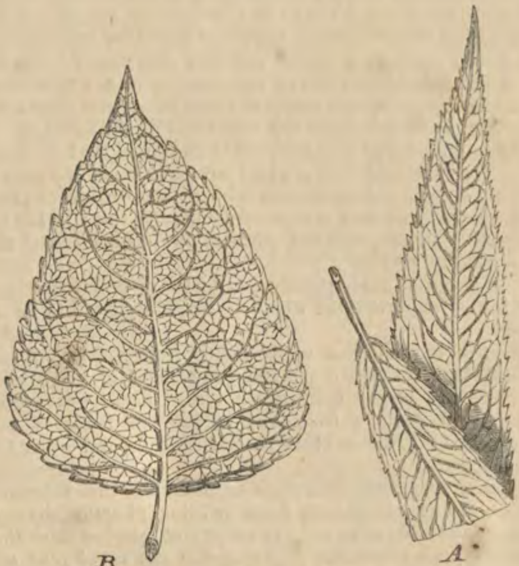
* Tea Countries of China.

† See Food and its Adulterations, p. 298.

Adulterations of Tea practised in this Country.

We now pass on to the consideration of *those adulterations which are practised in this country.*

Fig. 17.



A, Leaf of WILLOW ; *B*, ditto of POPLAR.

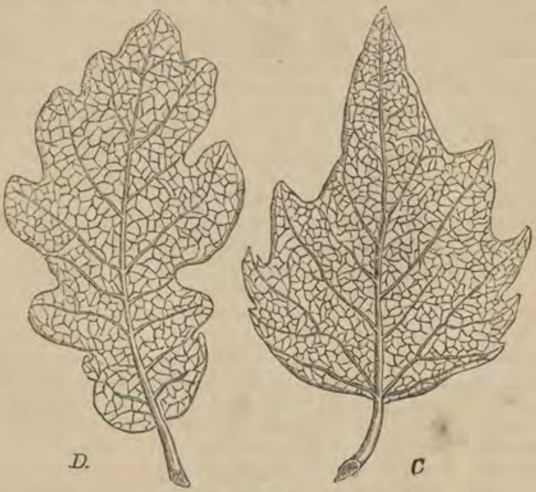
Adulterators in this country have succeeded in imitating with considerable skill the practices of the Chinese.

Thus they sometimes use foreign leaves to mix with genuine tea, and they face the fabricated article with various colouring matters, according as it is to resemble black or green tea.

These leaves, with the exception of sloe leaves, are never used whole; but they are broken up, mixed with gum and catechu, and made into little masses like those of Lie tea; these are subsequently coloured either black or green as may be required.

It is of but little consequence what kind of leaf is employed for this purpose; any leaves that are readily procurable will answer the purpose. The following leaves have been detected at different times, principally by the Excise, entering into the formation of spurious teas of British fabrication:—Beech, elm, horse-chesnut, plane, bastard plane, fancy oak, willow, poplar, hawthorn, and sloe.

Fig. 18.



C, Leaf of PLANE; *D*, ditto of OAK.

Some of the leaves above named are represented in the accompanying engravings.

The colouring matters employed are often more injurious than those used by the Chinese: the substances actually detected are the following: rose pink, Dutch pink, catechu, chromate of lead, sulphate of iron, Venetian red, soap-stone or French chalk, carbonate of lime, carbonate of magnesia, carbonate of copper, arsenite of copper, the chromates of potash, Prussian blue, and indigo.

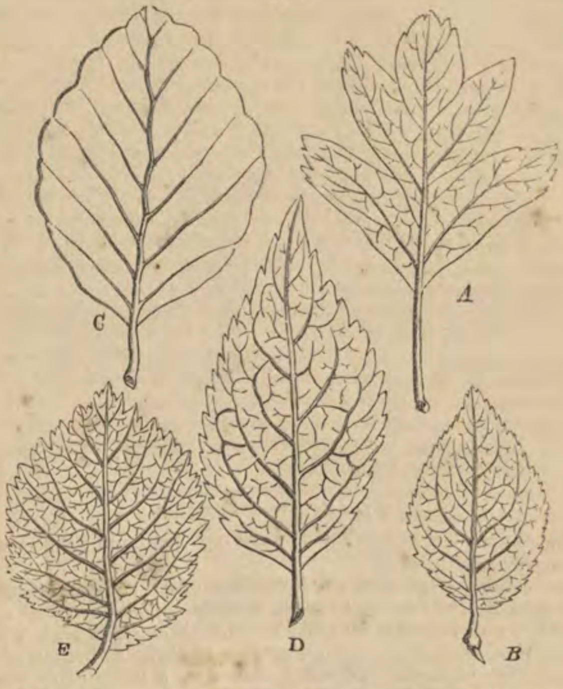
Dutch pink, rose pink, catechu, sulphate of iron, carbonate of lime, carbonate of magnesia, soap-stone, Prussian blue, and indigo have been repeatedly met with in adulterated tea, in some instances by the Excise authorities.

The following particulars in reference to the use of soap-stone or French chalk are taken from an article in the "Household Words" under the title of "Death in the Tea Pot:"—

"By the help of Mr. Slivers, we were enabled in a recent number to expose to an injured public some of the ingredients of metropolitan milk—'London Genuine particular.' A correspondent now makes a further revelation of how our tea-pots are defiled when it is innocently supposed that a pure beverage is in course of concoction.

“ ‘A short time since,’ he says, ‘a friend of mine, a chemist in Manchester, was applied to for a quantity of French chalk, a species of talc, in fine powder; the party who purchased it used regularly several pounds a week. Not being an article of usual sale in such quantity, our friend became curious to know to what use it could be applied; on asking the wholesale dealer who supplied him, he stated his belief, that it was used in “*facing*” tea (the last process of converting black tea into green), and that within the last month or two, he had sold in Manchester upwards of a thousand pounds of it. Our friend the chemist then instituted a series of experiments, and the re-

Fig. 19.



A, Leaf of the HAWTHORN; *B*, ditto of the SLOE, or WILD PLUM; *C*, ditto of the BEECH; *D*, ditto of the ELDER; *E*, ditto of the ELM.

⁂ The whole of the leaves, except that of the camellia, are figured on their under surfaces. The elm, plane, and oak leaves, from which the sketches were prepared, were of small size.

sult proved that a great deal, if not all the *common* green tea, used in this country, is coloured artificially. The very first experiment demonstrated fraud. The plan adopted was as follows : — A few spoonfuls of green tea at five shillings a pound, were placed on a small sieve, and held under a gentle stream of cold water flowing from a tap for the space of four or five minutes. The tea quickly changed its colour from green to a dull yellow, and upon drying with a very gentle heat gradually assumed the appearance of ordinary black tea. On making a minute microscopic examination of the colouring matter washed from the leaf, and which was caught in a vessel below, it appeared to be composed of three substances, particles of yellow, blue, and white. The blue was proved to be Prussian blue ; the yellow thought to be turmeric ; and the white, French chalk. If the two former be mixed together in fine powder, they will give a green of any required shade. It is made to adhere to the tea-leaf by some adhesive matter, and then it is "faced" by the French chalk, to give it the pearly appearance so much liked.

"'This simple experiment any one can perform. A gentleman assured me that a friend of his a short time since happened — though quite unintentionally on his part — to walk into a private room connected with the establishment of a wholesale tea-dealer, and there he saw the people actually at work converting the black tea into green ; the proprietor soon discovered his presence in the room, and before him, in no measured terms, severely reprimanded the workmen for having permitted a stranger to enter.'"

Carbonate of copper occurred to the extent of 35 per cent. in some tea which was seized in London by the Excise in 1843.

The tea into the facing of which the chromates of potash entered was seized in Manchester in 1845.

The following articles were likewise seized on the premises, evidently intended to be used in the colouring of adulterated tea : —

A mixture of chromate of lead and carbonate of lime.

Arsenite of copper.

A mixture of indigo, chromate of lead, and carbonate of lime.

A mixture of arsenite of copper, carbonate of magnesia, and Venetian red.

In 1848 other seizures of adulterated green tea occurred.

In some instances the colouring matters employed to face the tea have amounted to 7, 8, and even to 9 per cent.

Sometimes an inferior black tea, or a re-dried black tea, is artificially coloured, and so converted into a green tea.

Adulteration with Exhausted Tea-leaves.

At other times exhausted tea-leaves are treated with sulphate of iron, catechu, and gum, to give them colour, astringency, and gloss, and sold again as black tea, or, when coloured, as green tea.

The chemical composition of a tea thus made up from exhausted leaves, is of course very different from genuine and unused black tea, as appears from the following analyses: —

Unused Black Tea.

By Frank.		By Phillips.	
Tannin	40·6	Lignin	46·8
Gum	6·3	Gum	5·9
Woody fibre	44·8	Tannin	42·5
Glutinous matter	6·3	Albumen and colouring matter	4·8
Volatile matter and loss	2·0		
	100·0		100·0

Genuine green tea contains about the same proportion of gum as black.

Exhausted Black Tea, re-dried and made up with Gum.

	By Phillips.	
Lignin	78·6	78·1
Gum	15·5	20·5
Tannin and colouring matter	5·9	1·4
	100·0	100·0

When the re-dried leaves, in addition to being made up with gum, are artificially coated or coloured, nearly the same differences of composition exist.

Contrasting the analyses of exhausted tea-leaves made up with gum, with those of genuine tea, it will be seen that while the amount of tannin in the former is very much reduced, the quantity of lignin, and also of gum, is greatly increased.

The following observations in reference to the employment of exhausted tea-leaves, are by Mr. George Phillips, of the Inland Revenue Office: —

"In the year 1843, there were many cases of re-dried tea-leaves, which were prosecuted with vigour by this board, and the result was, so far as we could ascertain at the time, the suppression of the trade. It was supposed, in 1843, that there were eight manufactories for the purpose of re-drying exhausted tea-leaves in London alone, and several besides in various parts of the country. The practice pursued was as follows: — Persons were employed to buy up the exhausted leaves at hotels, coffee-houses, and other places, at 2½*d.* and 3*d.* per pound. These were taken to the factories, mixed with a solution of gum, and re-dried. After this, the dried leaves, if for black tea, were mixed with rose pink and black-lead, to face them, as it is termed by the trade."

These fabricated teas are seldom sold alone to the public, but are used for mixing with the more genuine teas.

Adulteration with Foreign Leaves.

As illustrating the adulteration of tea with foreign leaves, the following cases may be cited: —

On the 18th of December 1850, a seizure of spurious tea was made by the Excise in Liverpool, on the premises of John Stevens, where a regular manufactory was carried on. Samples of the articles seized were presented to us by Dr. Muspratt and Mr. Phillips of the Inland Revenue. One of the samples consisted of a mixture of the entire dried leaves of the sycamore, and horse-chesnut. In another specimen the leaves were so broken down that it was scarcely possible to identify them without the aid of the microscope. A third sample consisted of large lumps of irregular size and shape, formed of the broken leaves, including even the stalks, agglutinated by means of catechu. In another specimen these masses were broken down into smaller masses or fragments, resembling those of gunpowder tea. In this state the article was ready either for mixing with genuine black tea, or for being faced, in imitation of green gunpowder; lastly, other samples were coloured with indigo, and very closely resembled the green gunpowder tea of the Chinese.

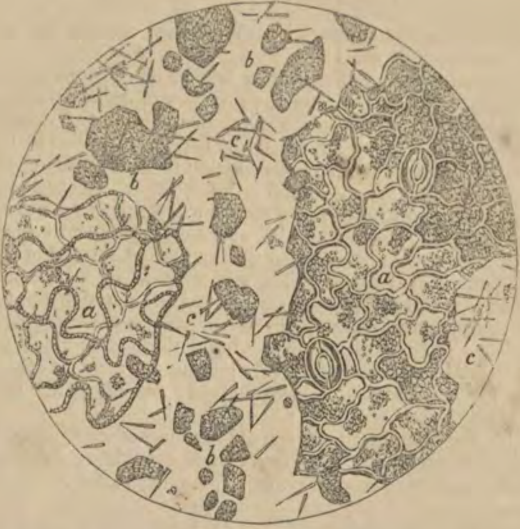
In this case, then, we have not only the use of foreign and worthless leaves, but these were formed into masses resembling those of Lie tea; and lastly these masses were artificially coloured after the manner of the Chinese.

But seizures of adulterated tea of British fabrication have been made even more recently than that above referred to. The following account of proceedings of the Clerkenwell Police Court, is copied from "The Times" of May, 1851: —

"Edward South, and Louisa, his wife, were placed at the bar, before Mr. Combe, charged by Mr. Inspector Brennan, of the G division, with being concerned in the manufacture of spurious tea.

"It appeared from the statement of the inspector, that in consequence of information that the prisoners and others were in the habit of carrying on an extensive traffic in manufacturing spurious tea on the premises situate at 27½. Clerkenwell-close, Clerkenwell-green, on Saturday evening, at about seven o'clock, the witness, in company with Sergeant Cole, proceeded to the house, where they found the prisoners in an apartment, busily engaged in the manufacture of spurious tea. There was an extensive furnace, before which was suspended an iron pan, containing sloe-leaves, and tea-leaves which they were in the practice of purchasing from coffee-shop keepers, after being used. On searching the place, they found an immense quantity of used tea, bay-leaves, and every description of spurious ingredients, for the purpose of manufacturing illicit tea, and they were mixed with solution of gum and a quantity of copperas. The heat of the place was so excessive, that the officers could scarcely remain in it, but the prisoners did not seem at all oppressed by it. The woman was employed in stirring about the bay-leaves and other compositions with the solution of gum in the pan; and in one part of the room there was a large quantity of spurious stuff, the exact imitation of genuine tea. In a back room they found nearly 100 lbs. weight of re-dried tea-leaves, bay-leaves, and sloe-leaves, all spread on the floor drying. The inspector told the prisoners that he was a police-officer, and also an inland revenue officer, and he must take them into custody, together with the whole of the ingredients and apparatus for making the spurious tea. Mr. Brennan added that the prisoners had pursued their nefarious traffic most extensively, and were in the habit of dealing largely with grocers, chandlers, and others, especially in the country. The various articles produced, prior to their completion, had the most disgusting appearance, and were evidently prejudicial to health. He had communicated with the Excise authorities, who considered it a case of such importance to

Fig. 20.

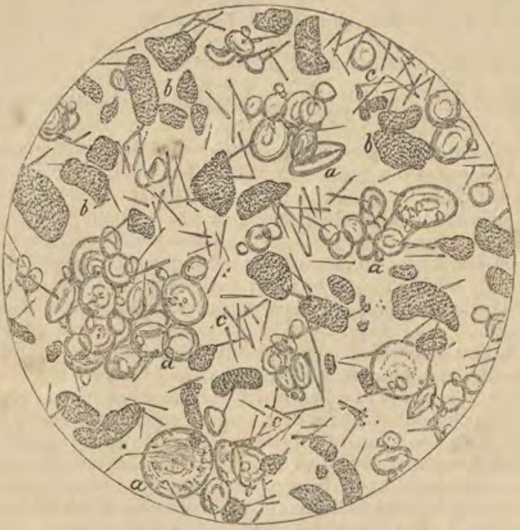


LA VENO BENO.

a a, fragments of the *sumach leaves*; *b b*, particles of gum *catechu*; *c c*, *crystals* usually present in catechu. Magnified 350 diameters.

the public, that they requested the withdrawal of the present charge, in order that they might prosecute the prisoners under the Excise laws; being determined, if possible, to put a stop to such abominable proceedings."

Fig. 21.



THE CHINESE BOTANICAL POWDER.

a a, starch corpuscles of *wheat*; b b, fragments of *catechu*; c c, *crystals*. Magnified 350 diameters of same.

Before concluding the subject of the adulteration of tea, two articles sometimes employed in its adulteration have to be noticed, viz., *La Veno Beno*, and Chinese Botanical Powder.

La Veno Beno is a coarse powder of a reddish-brown colour, and it consists of between 80 and 90 per cent. of catechu, and the remainder of fragments of sumach leaf.

It is recommended for its strengthening properties, especially for strengthening the nerves and the voice, but above all for its economy; a threepenny packet, it is asserted, will go as far as a quarter of a pound of tea, with which it is reccommended that it should be mixed.

The Chinese Botanical Powder, is a preparation got up in imitation of La Veno Beno, and is principally used for the same purpose, namely, to mix with tea. It consists of catechu and wheat-flour. The directions for its use are as follows:—Take half a teaspoonful of the powder, to two teaspoonfuls of tea, and it will produce (so runs the advertisement) a strength equal to four teaspoonfuls of tea.

Both these powders are very astringent, and therefore their general use is highly objectionable; they are, in fact, active medicinal preparations.

RESULTS OF THE EXAMINATION OF SAMPLES AS SOLD TO THE PUBLIC, &c.

The results of the microscopical and chemical examination of some hundreds of samples of tea as imported, and as sold to the consumer, in this country, briefly summed up, are as follows:—

That the great bulk of the *Black teas* used, as the Congous and Souchongs, *are genuine.*

That the Black teas, known as Scented Caper, and Scented Orange Pekoe, are invariably glazed or faced with *plumbago*, and sometimes with a little *Prussian blue* or *indigo*, *turmeric*, and *sulphate of lime*, or *China clay*.

Further, that Scented Caper or Chulan is often adulterated with *Lie tea*, *paddy-husk*, and *leaves other than those of tea.*

That *several varieties of a spurious Caper*, *or black Gunpowder*, *are prepared*, which consist of *tea-dust*, and sometimes *the dust of other leaves*, and *sand*, made up into little masses with *gum*, and faced or glazed with *plumbago*, *Prussian blue*, and *turmeric-powder:* in some cases these imitations are sold separately, but most frequently they are used to mix with and adulterate the better qualities of Caper—viz. those which are made of tea faced with plumbago only.

With respect to *Green tea* the principal conclusions are—

That these teas, with the exception of a few of British growth and manufacture, from Assam, *are invariably adulterated*—that is to say, are glazed with colouring matters of different kinds.

Thus in this country there is really no such thing as a green tea—that is, a tea which possesses a natural green hue.

That *the colouring matters used* are in general *Prussian blue*, *indigo*, *turmeric-powder*, *sulphate of lime*, and *China clay*, other ingredients being sometimes but not frequently employed.

That *green teas*, *and more especially the Gunpowders*, *in addition to being faced and glazed*, *are more subject to adulteration in other* ways than black teas, excepting Caper, *as by admixture with leaves not those of tea*, *with paddy-husk*, and *particularly with Lie tea.*

That Lie tea is prepared so as to resemble green tea, and is extensively used by the Chinese themselves to adulterate Gunpowder tea; it was also, until recently, sent over to this country in vast quantities, and was employed for the same purpose by our own tea-dealers and grocers. It is still sometimes met with, especially in mixed green teas.

That inferior samples of green tea, especially Twankay, are not only artificially coloured, but *they also sometimes contain foreign leaves, paddy-husk, and other foreign matters.*

The above are the more important conclusions as to the condition of black and green teas as imported, but these articles undergo further deterioration in our own country. Thus it has been shown —

That *exhausted tea-leaves are sometimes made up with gum,* &c., *and resold to the public as genuine black tea, and, when artificially coloured and glazed, even as green tea.*

That *the substances employed in the colouring are in many cases very much more objectionable and injurious than those used by the Chinese, being sometimes highly poisonous.*

That *it is no uncommon thing for tea, both black and green, to be fabricated from various British leaves, leaves not those of tea, and possessing no properties in common with the leaves of that plant.*

That *black Chulan and Lie tea, when coloured, have been known to be employed by our own dealers and grocers for the adulteration of green tea.*

Of the adulterations noticed, those practised by the Chinese are of course by far the most important, because they extend to a very considerable portion of the tea consumed in this country; at the same time, the frauds resorted to by our own dealers must not be lost sight of.

It has thus been shown that tea is subject to a large amount of adulteration.

It is interesting to contrast the so-called green teas of China with the green teas sometimes imported from Assam, but, more particularly, with the tea called Kumaon. The difference of appearance is usually very great; the leaves of these teas are of a dull and yellowish-green colour, so different from the Chinese teas, that they would scarcely be recognised by an ordinary observer as green tea at all. This marked difference arises from the fact that the Kumaon and sometimes the Assam teas are not usually coloured or glazed like the Chinese teas, although the Assam are so not unfrequently to some extent.

One beneficial result which has followed from the publication of our Report on the adulteration of tea in "The Lancet" and in the author's work entitled "Food and its Adulterations" may now be referred to; it is one which scarcely could have been anticipated.

It appears that the Chinese themselves have within the last year or so begun to give up the practice of colouring or glazing their green teas. This is shown, first, by the fact that not unfrequently they now send to this country chests of uncoloured green tea, the chests containing it even being branded with the word "*uncoloured;*" and secondly, by the improved appearance presented by many of those teas which are coloured or glazed, the proportion of colouring matters now used being much less.

Uncoloured green teas are even commonly advertised for sale: it should be known, however, that in many cases these are nothing more than ordinary green teas, from which the colouring matter has been removed by means of steam.

ON THE DETECTION OF THE ADULTERATIONS OF TEA.

The detection of the adulterations of tea may be considered under the four following heads: viz. the detection of foreign leaves; of the various substances employed for the facing or glazing of tea; of exhausted tea-leaves; and of Lie tea.

On the Detection of Foreign Leaves.

The teas in which foreign leaves are most likely to be met with, are those of low quality; as Twankay, inferior Gunpowder, Chulan, and Lie tea; also in teas of British fabrication.

The leaves may occur in two states, either more or less entire, or broken up into fragments which may be found either loose in the dust of tea, or else agglutinated by means of a solution of gum or starch into masses artificially coloured.

For the detection of foreign leaves a thorough acquaintance with the tea-leaf itself is necessary, its shape and various sizes, the venation of the edges, the distribution of the veins, and lastly, its microscopical structure, embracing particularly the size of the cells, stomata, &c. All these points are well delineated in the figures of the tea-leaf already given.

In order to facilitate the identification of any foreign leaves met with, a knowledge is desirable of the characters of the leaves most likely to be encountered. For this purpose it will be well to examine carefully the engravings of foreign leaves actually detected in adulterated tea contained in this work.

To discover foreign leaves in a more or less entire state, the tea should be infused in hot water for a few minutes, and all suspicious pieces unrolled and examined, and compared with the tea-leaf itself; regard being had especially to the distribution of the veins, and the edges of the leaves or portions of leaves.

To detect foreign leaves much broken up, as in Lie tea and in tea-dust, the microscope must be resorted to; if in Lie tea, the masses must be disintegrated by means of hot water, and the fragments torn up with needles, and examined diligently and carefully with that instrument.

On the Detection of Substances entering into the Facing of Tea.

As has already been stated, a very great variety of substances is employed in the facing of tea. Of these, some occur in teas of Chinese manufacture; but others — and these sometimes of a more injurious character — have been met with in tea fabricated at home.

The principal substances used by the Chinese are, for green tea, Prussian blue, indigo, turmeric, and some white powder, usually Kaolin or China clay, but occasionally gypsum or sulphate of lime; and for certain black teas, black-lead, as well as in some cases smaller quantities of the pigments previously mentioned.

By the mixture of blue, yellow, and white colours, green pigments or dyes are produced of various tints.

The detection of all the substances referred to, is by no means difficult.

The first thing necessary is to ascertain whether the tea be really artificially coloured or not.

For this purpose, if the leaves be coated to any considerable extent, it will be sufficient simply to view one or two of them, as opaque objects, with a glass of one inch focus, when the colouring matters entering into the composition of the facing will be detected as minute specks or particles, each reflecting its appropriate tint.

Another method of determining the same point is to scrape gently the surface of two or three of the leaves with a penknife, when, if they be faced, the colouring matters may be detected in the powder thus separated, viewed as an opaque object.

A third method is to place five or six leaves on a slip of glass, moistening them with a few drops of water, and after the leaves have become softened, firmly squeezing the water out between the finger and thumb; this will then be found to contain more or less of the ingredients forming the facing, should such have been employed.

Or, should it be desired to obtain the results on a large scale, half an ounce or so of the leaves may be agitated in a little water for a few minutes; this will detach much of the facing, without unfolding the leaves, and after a time the facing will collect as a sediment at the bottom of the vessel.

Lastly, the tea-dust, more or less of which is present in nearly every sample of tea, is usually found to contain the ingredients used in the facing in considerable quantity, and from its examination satisfactory results may in general be very readily obtained.

Having by one or other of the above processes determined whether the sample of tea be faced, the next step is to ascertain the nature of the substances used for this purpose.

Ferrocyanide of iron or Prussian blue.—The blue colouring matter has generally been found to be either Prussian blue or indigo, but most frequently the former.

Prussian blue may be recognised under the microscope by the angular form of the fragments and by their brilliant and transparent blue colour, but most decidedly by the action of liquor potassæ, which quickly destroys the blue, turning the fragments of a dull reddish-brown colour, the original colour being restored on the addition of dilute sulphuric acid. These reagents may be readily applied in very minute quantities to the smallest fractions of Prussian blue visible in the field of the microscope.

In general, the identification of the Prussian blue, by the means just pointed out, is sufficient, but in some cases a more direct chemical analysis may be required.

For this purpose the following proceeding must be adopted, which applies equally to indigo and any other pigment or substance with which the tea may be glazed, and which is required to be procured in a separate state in considerable quantity.

An ounce or more of the tea is to be agitated for several minutes with warm water, the leaves separated by straining, and the liquid set aside at rest for some hours, until the colouring matters have completely subsided. These may be obtained by decantation, and after washing may be dried in readiness for analysis.

The following are the chemical properties of ferrocyanide of iron, or Prussian blue:—It is insoluble in water, in alcohol, and in dilute acids. Concentrated sulphuric acid forms with it a white pasty mass, from which water again separates it unaltered; nitric acid decomposes it; concentrated hydrochloric acid ultimately abstracts part of its iron; sulphuretted hydrogen, iron and zinc filings, render it white, in consequence of the abstraction of part of the cyanogen. It is not decolourised by chlorine. The alkalies discharge its colour, decompose it into soluble ferrocyanides, and oxide of iron, which is precipitated.

Indigo.—This substance is distinguished under the microscope by the irregular form of the particles, their granular texture, and greenish-blue tint, but chiefly by the fact that the colour is not discharged by liquor potassæ at ordinary temperatures.

The following are some of the more important chemical characteristics and properties of indigo:—It exhibits a coppery lustre on being rubbed with the nail; it is not soluble in water, dilute acids, ether, or alcohol; it is not attacked by liquor potassæ at ordinary temperatures, but, distilled therewith, it is decomposed and converted into a yellowish brown liquid, aniline is formed, as shown by the development of a beautiful violet-blue colour on the addition of a solution of chloride of lime. It is freely dissolved by strong sulphuric acid, forming a deep blue solution; is bleached by chlorine: heated in a test tube, it sublimes in rich violet vapours.

Turmeric.—The only certain means by which turmeric powder when mixed with other articles can be discovered, is furnished by the microscope. A description of the minute structure of turmeric will be given hereafter: in the meantime it will be sufficient to state that turmeric may be at once identified by means of the large yellow cells of which it is mainly composed, and the form of the starch granules with which these are filled.

There are no chemical tests by which turmeric may be identified: it becomes brown on the addition of alkalies, in which respect it comports itself like most other yellow vegetable colouring matters: its decoction becomes much darkened by iodine, showing the presence of starch; by this character, indeed, turmeric may in some cases be distinguished from certain other vegetable yellow pigments which do not contain starch.

Black-lead.—Graphite, plumbago, or black lead, the substance so familiar to housemaids, consists of carbon and iron, usually in the proportion of 95 per cent of the former to 5 per cent of the latter.

The jet-black glossy and metallic appearance of this substance is so characteristic, as to serve in most cases for its identification.

Apart from the evidence of the presence of this substance afforded by the eye alone, it may be detected in other ways.

If a thin slice be removed from the surface of one of the leaves faced with this substance, and placed under the microscope, it will be seen to be thickly studded with numerous minute black particles.

Again, if one or two teaspoonfuls of black-leaded tea be infused in boiling water, the liquid, after a time, will in many cases, where the quantity of facing is considerable, acquire a blackish hue, and on evaporation, the bottom of the vessel containing it will be found to exhibit the dark, shining, and characteristic coating of black-lead.

Lastly, if a small quantity of it be weighed and ignited, the whole of the carbon will be dissipated, in or about the proportion of 95 per cent., and the iron in the state of oxide will remain behind.

China Clay, or Kaolin, is prepared from decaying granite, and is the result of the disintegration and partial decomposition of the felspar and mica of that mineral.

Talc or Mica occurs, as is well known, in laminated plates; it refracts the light powerfully, and exhibits a considerable amount of iridescence. It consists of silicate of alumina, with tersilicate of potassa.

Felspar resembles very closely mica in its composition, and is composed of single equivalents of the neutral silicates of potash and alumina.

If the white powder facing the tea consist of China clay, we must proceed as follows to determine its nature:—A quantity of the tea dye having been separated either by washing or by shaking some of the tea about in the dry state, it must be heated to redness; by this means the turmeric and Prussian blue will be destroyed, and the white powder obtained nearly pure, containing chiefly the iron derived from the Prussian blue.

The powder must be acted upon with very dilute hydrochloric acid; the silica will remain undissolved, but the alumina and oxide of iron will be taken up, but are precipitated on the addition of ammonia. Such an analysis as this is seldom required, as the determination of the exact composition of the white powder used is rarely necessary.

Sulphate of Lime.—The leaves of tea, especially those from Assam, are sometimes dusted over with sulphate of lime, and this in some cases where no other colouring substance is employed.

This salt should be dissolved in weak hydrochloric acid, the solution further diluted with water; one part of the solution must be tested with chloride of barium for sulphuric acid, and the other with oxalate of ammonia for lime. It is not often, in the case of tea, that this analysis is required, any more than that for China clay or black-lead.

It now remains that the methods by which the several substances which have been discovered, from time to time, entering into the facing of tea of British fabrication, should be considered.

The principal of these substances are Dutch pink, rose pink, logwood, turmeric, carbonate of lime, carbonate of magnesia, steatite, soap-stone or silicate of magnesia, chromate of lead, the chromates of potash, ferrocyanide of iron, indigo, carbonate of copper, acetate of copper, arsenite of copper.

As carbonate, acetate, and arsenite of copper, chromate of lead, and the chromates of potash, are rarely used for the facing of tea, and as the methods of detecting these poisonous salts are given under the articles Sugar Confectionary and Snuff, it is not necessary to introduce them in this place.

The processes for the detection of Prussian blue, indigo, and turmeric, have already been given; there remains to describe, therefore, those only for the detection of Dutch pink, rose pink, logwood, the carbonates of lime and magnesia, and French chalk or soap-stone.

Dutch Pink.—Although called *Dutch pink*, this substance is of a bright yellow colour; it consists of a vegetable dye in combination with chalk or carbonate of lime. It is the yellow pigment most frequently used in this country in the facing of spurious green tea.

For its detection the following method should be pursued:—An alkali should first be applied to the yellow dye, in order to determine, in the first place, whether it be vegetable or not: if it turn brown, there is no doubt about its vegetable character. In the next place, a minute portion of it should be examined under the microscope, with the view of ascertaining whether it is turmeric or not: if the cells of turmeric are not visible, and if it effervesce with an acid, there is no doubt that the dye is vegetable, and most probably Dutch pink.

Rose Pink and Logwood.—Rose pink consists of the colouring matter of logwood in combination with carbonate of lime. An infusion of the wood is first prepared through which the lime is diffused, and this in subsiding carries down with it the colouring matter.

This pigment is distinguished by the action of acids which intensify its red colour, and of alkalies which turn it brown, as well as by the presence of carbonate of lime or chalk.

Extract of logwood, Dr. Normandy states, is sometimes used in the adulteration of teas represented as Souchong and Pekoe.

This may be detected by moistening a few of the leaves with water, and rubbing them upon a piece of white paper, which, if logwood is present, will be stained bluish-black. Moreover, a few drops of sulphuric acid added to a concentrated infusion of the tea cause it to turn red.

Carbonate of Lime or Chalk.—If on the addition of an acid the particles of white powder effervesce, it most probably consists of chalk. In order to render the determination a matter of certainty, however, the powder must be dissolved in weak hydrochloric acid, and the lime precipitated by means of oxalate of ammonia: this reagent does not precipitate magnesia, should that alkaline earth happen to be in solution.

Carbonate of Magnesia.—The powder must first be dissolved in dilute hydrochloric acid, the solution treated with chloride of ammonium, and ammonia added in slight excess; the magnesia is then precipitated by means of phosphate of soda; the precipitate must be collected and converted into the pyrophosphate by ignition, from which the carbonate of magnesia is calculated. Should lime also be present, this must first be removed by means of oxalate of ammonia.

French Chalk, Soap-stone, or Silicate of Magnesia.—The indigo or Prussian blue and turmeric having been destroyed by ignition, the residuary powder is to be treated with dilute hydrochloric acid; the magnesia will be dissolved, but not the silicic acid. The magnesia may then be precipitated as before, care being taken to remove the lime should any be present, and the silicic acid ignited and weighed.

On the Detection of Exhausted and Re-dried Tea-leaves.

Exhausted tea-leaves occur in two forms. Usually they are made up in imitation of black tea, but occasionally of green also: the detection is easier in the former than in the latter case. In the case of black tea the imitation can often be detected by the eye alone, but in other cases a chemical analysis of the leaves is necessary.

One character by which the re-dried leaves may be known, is the fold or roll of the leaves: this is less regular and uniform than that of unused tea, the surfaces being agglutinated together, and many flat pieces of leaves occur.

Another character is the glossy appearance presented by the leaves, due to the *gum* with which they are almost constantly made up. By the roll or twist of the leaves, and by the glossy appearance presented by them, re-dried tea may in general be easily recognised; but when a chemical analysis is requisite, the following proceeding must be adopted. The per centage of tannin, of gum, and of woody fibre must be determined: if the leaves be really exhausted there will be a great deficiency of tannin, and an excess of woody fibre and especially of gum.

In genuine and unused tea, according to the quality, the tannin has been ascertained to vary from 30·0 to 45·0 per cent in the case of superior teas; in used tea to range from 7·2 to 0·7 per cent; or the tea may even

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be completely exhausted of its tannin. The gum ranges from 6·3 to 5·9 per cent. in the one case, and from 20·5 to 11·6 per cent in the other. Lastly, the woody fibre in unused tea varies from 44·8 to 46·8, and in exhausted tea from 92 8 to 72·9 per cent. The process for determining the amounts of tannin, gum, and insoluble residue or woody fibre, will be found described at p. 68. Green tea usually contains about the same proportion of gum as black tea, but less tannin.

Analysis of Green Tea, by Mr. Phillips.

Lignin - - - -	55·3
Gum - - - - -	5·4
Tannin and albumen - - -	37·1
Colouring matter - - -	2·2
	100·0

But other matters are sometimes added to exhausted tea-leaves besides gum, as catechu and sulphate of iron, in order to make up for the deficiency of tannin.

Detection of Catechu. — Catechu consists in great part of tannin: there will be ground for believing that this substance has been employed if, on analysis, both the gum and tannin are in excess; for the one is not likely to be employed without the other. The presence of catechu may also be inferred when, there being no excess of gum, the tannin is itself greatly in excess.

A certain roughness and astringency in the tea is likewise indicative of the presence of catechu.

When a solution of sulphate of iron is brought into contact with a solution of tannin or one of tea which contains a large amount of tannin, the liquid becomes deeply coloured; and it is on this account that the sulphate of iron is sometimes added to exhausted tea-leaves, to give an appearance of strength.

Detection of Sulphate of Iron. — If the infusion made from the exhausted tea present a certain darkness of appearance, the presence of sulphate of iron may be suspected; if on adding a little tincture of galls the colour is heightened, but little doubt remains. Lastly, if necessary, which is but seldom the case, — the infusion of the leaves may be analysed for sulphuric acid, and the ash of the evaporated infusion for iron, both of which must be determined quantitatively. The sulphuric acid must be thrown down by means of chloride of barium or nitrate of baryta, the precipitate weighed, and the quantity of sulphuric acid calculated from it. It should be remembered that tea naturally contains a small quantity of sulphuric acid, chiefly in the combined state, derived partly from the leaves, but principally from the water used in making the infusion.

The presence of iron may be determined by means of tincture of galls, as already noticed, or of ferrocyanide of potassium, which gives a blue precipitate of ferrocyanide of iron or Prussian blue. The quantity of iron contained in the tea may be thus ascertained:—A dried and weighed portion of the tea is incinerated: if much iron is present, the ash will be coloured more or less with the red oxide of that metal. The ash is next boiled with dilute hydrochloric acid: this takes up the iron and alumina, and phosphates, which are again precipitated on the addition of excess of ammonia: the precipitate must be collected, ignited, and weighed. Iron is usually determined in combination with alumina, and the phosphates occurring in tea are in general not so large as to affect materially the accuracy of the result. The phosphates may however be removed previous to the precipitation of the iron and alumina, by digesting the ash of the incinerated tea in an exceedingly weak solution of hydrochloric acid,—so weak that it will not affect the iron and alumina. For further details refer to p. 149.

When exhausted tea-leaves have been faced, and so converted into an imitation of green tea, the detection of the fraud by the eye alone is more difficult than in the case of black tea, as, although we have still the irregular form of the leaves, we have not the unnatural gloss to guide us. In this case, therefore, we must resort to chemical analysis.

Exhausted tea-leaves are of course not only deficient in tannin, but likewise in theine; in some cases, therefore, it may be desirable to determine the amount of that important constituent of tea present, which may be done by following one or other of the processes described at page 69.

On the Detection of Lie Tea.

The detection of Lie tea is by no means difficult: in some cases it may be discriminated by the irregularity in the form of the particles or masses, and by their increased weight owing to the sand which they contain.

Before pronouncing an opinion as to the nature of any sample, it is however in all cases necessary to act on the masses with hot water. When hot water is applied to genuine tea, the masses quickly unfold and expand into leaves or portions of leaves; when to Lie tea, they break down and become disintegrated; no leaf appearing, and the residue is heavy, gritty, and dirty-looking. Again, if one of the masses be placed between the teeth it feels gritty.

But since Lie tea often occurs, as already stated, mixed with other teas, it is necessary to look them well over and to pick out all the masses which present a suspicious appearance, and to treat them with hot water.

Having ascertained that the tea under examination consists either entirely or in part of Lie tea, it becomes necessary, in those cases in which we desire to carry the analysis further, to very carefully examine the leaf-dust, which the masses always contain, with the microscope, in order to determine whether any foreign leaf-dust be present.

Lastly, in some cases we may desire to know the per-centage of sand which may be present. For this purpose a weighed portion of the tea must be incinerated, and the ash weighed. Genuine tea furnishes on an average about 5 per cent of ash, and Lie tea as much in some cases as 50 per cent.

The following results were obtained by Mr. Warington from the incineration of a variety of teas. They will be found useful for the purpose of comparison: —

Ash of Genuine Tea.		*Ash of Lie Tea, or Tea adulterated with Lie Tea.*	
Gunpowder	5·0	Lie Gunpowder No. 1.	45·5
Kemaon Hyson	6·5	„ No. 2.	34·0
Assam Hyson	6·0	Lie flower Caper	37·5
Scented Caper	5·5	Mixtures containing these Lie teas	11·0 22·5

In Lie tea of British fabrication the leaves are almost always foreign, and the masses rarely contain sand.

For the determination of the nature of the substances employed in the facing of Lie tea when these have been used, reference should be made to the remarks commencing on p. 96.

In consequence of the war, a retrograde step in the duty was enacted, and it stands at 1*s.* 9*d.* per lb. until the 5th of April, 1857; after that day it will be 1*s.* 3*d.* until 5th April, 1858. Thenceforward 1*s.* per lb.

Home consumption 1854, 61,970,341 lbs. Duty 1*s.* 6*d.* after 5th April of that year.

In 1855, 63,454,035 lbs. Duty 1*s.* 9*d.*

First 9 months of 1856, 48,083,784 lbs., which is a slight diminution, the consumption for the same 9 months of 1855 being 48,140,288 lbs.

The following question, and answer by Mr. George Phillips, will serve as an illustration of the gross ignorance of the Excise, even in regard to the adulteration of the few articles of consumption under its supervision.

Mr. Moffatt. "Is it within your experience that no poisonous substance is used in the facing of tea at the present time?"

Reply. "It is possible there might be some samples found now coloured with Prussian blue; but *I have not seen any myself.*"

Now let the reader remember that all the green teas in this country are artificially coloured, and that one of the substances used is in ninety-nine out of a hundred cases Prussian blue, and he will have some notion of the ignorance and incompetence of the Excise.

Again, it appears by the returns placed before the Committee by Mr. George Phillips, that in twelve years the Excise, with its 70 chemists and 4000 inspectors, examined only—and this in a very superficial way—142 samples out of 900,000, the number of packages imported.

COFFEE, AND ITS ADULTERATIONS.

The beverage coffee consists of an infusion in boiling water of the roasted seeds of a plant which has received the Botanical name of *Coffea Arabica*, and which is said to be indigenous in certain districts of Southern Abyssinia, where it grows, with the profusion of a wild weed, over the rocky surface of the country.

In Abyssinia, coffee has been in use from time immemorial; in Persia it was in use as early as 875; it was introduced into Arabia about the fifteenth century; and about the middle of the sixteenth century it began to be employed in Constantinople; while we learn, on the authority of Professor Johnston, it was not until the latter half of the seventeenth century that it made its way into Europe, first into London, and some years subsequently to Marseilles.

In Johnston's "Chemistry of Common Life" we meet with the following description of the coffee plant or tree:—

"The coffee tree, when in good health and full grown, attains a height in some countries not exceeding eight or ten feet, but in others averaging from fifteen to twenty feet. It is covered with a dark, smooth, shining, and evergreen foliage. It is sown in nurseries, transplanted when about six months old, in three years comes into full bearing, and in favourable circumstances will continue to bear for twenty years. It delights in a dry soil and a warm situation; its flowers are pale, white, fragrant, and rapidly fading; its fruit like that of the cherry tree, but it grows in clusters; within the fruit are the seeds or berries. On dry and elevated parts the berries are smaller and have a better flavour, but berries of all sizes improve in flavour or *ripen* by keeping. The small berries of Arabia will ripen in three years; but the worst coffee produced in America will in from ten to fourteen years become 'as good, and acquire as high a flavour, as the best we now have from Turkey.' "—*Ellis.*

The seeds, improperly called berries, of Arabian or Mocha coffee are small, and of a dark yellow colour; those of Java, and East Indian are larger, and of a paler yellow; while those of Ceylon, West Indian, and Brazilian coffee possess a bluish or greenish-grey tint.

The dried fruits or berries are rarely imported: occasionally, however, the seeds contained in their endocarp or husks are met with in commerce.

Recently the very important fact has been made known that the leaves possess, to a certain extent, the composition as well as many of the properties of the seeds, and hence their introduction into this country has been proposed. It appears that a beverage made from roasted coffee-leaves has long been used in the Eastern Archipelago, especially in Sumatra.

Mr. Ward, who has been many years settled in Sumatra, states,—

"As a beverage the natives universally prefer the leaf to the berry, giving as a reason that it contains more of the bitter principle, and is more nutritious. In the lowlands, coffee is not planted for the berry, not being sufficiently productive, but for the leaf; the people plant it round their houses for their own use. It is an undoubted fact, that everywhere they prefer the leaf to the berry."[*]

Chemical Composition and Properties of the Coffee Seed.

The following quantitative analyses of coffee are by Schrader and Payen:[†] —

Raw Coffee.

Schrader.

Peculiar caffeic principle	17·58
Gummy and mucilaginous extract	3·64
Extractive	0·62
Resin	0·41
Fatty oil	0·52
Solid residue	66·66
Loss water	10·57
	100·00

Roasted Coffee.

Schrader.

Caffeic principle	12·50
Extractive	4.80
Gum and mucilage	10·42
Oil and resin	2·08
Solid residue	68·75
Loss	1·45
	100·00

Payen's Analysis of Raw Coffee.[‡]

Cellulose	34·000
Water hygroscopic	12·000
Fatty substances	10 to 13·000
Glucose, dextrine, and undetermined vegetable acid	15·500
Legumine, caseine (glutine)?	10·000
Chlorogenate (caffeate) of potash, and caffeine	3·5 to 5·000
Nitrogenous substance	3·000
Free caffeine	0·800
Concrete essential oil	0·001
Aromatic fluid, essential oil	0·002
Mineral substances	6·697

According to Messrs. Graham, Stenhouse, and Campbell, raw coffee contains as much as from 6 to 7 per cent of cane sugar; this is either entirely destroyed by the roasting, or it rarely exceeds 1·12 per cent.

According to the same authorities, the nitrogen in roasted coffee lies between 2½ and 3 per cent.

The following analyses of the *ash* of coffee are by Messrs. Graham and Stenhouse:[§] —

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[*] Pharmaceutical Journal, vol. xiii. p. 208.

[†] Chemical Gazette, vol. v. p. 34., 1847.

[‡] Ibid.

[§] Chemical Report on the mode of detecting Vegetable Substances mixed with Coffee.

Analyses of the Ash of Coffee.

	Plantation Ceylon.	Native Ceylon.	Java.	Costa Rica.	Jamaica.	Mocha.	Neilgherry.
Potash	55·10	52.72	54·00	53·20	53·72	51·52	55·80
Soda	—	—	—	—	—	—	—
Lime	4·10	4·58	4·11	4·61	6·16	5·87	5·68
Magnesia	8·42	8·46	8·20	8·66	8·37	8·87	8·49
Sesquioxide of iron	0·45	0·98	0·73	0·63	0·44	0·44	0·61
Sulphuric acid	3·62	4·48	3·49	3·82	3·10	5·26	3·09
Chlorine	1·11	0·45	0·26	1·00	0·72	0·59	0·60
Carbonic acid	17·47	16·93	18·13	16·34	16·54	16·98	14·92
Phosphoric acid	10·36	11·60	11·05	10·80	11·13	10·15	10·85
Silica	—	—	—	—	—	—	—
Sand	—	—	—	—	—	—	—
	100·63	100·20	99·97	99·06	100·18	99.68	100·04

The chief peculiarities of the composition of the ash of coffee, are the absence of soda and the small quantity of silica present: this, indeed, is so small as to render it doubtful whether it contains any but that which is accidentally adherent to the berries. Contrasted with the ash of chicory, several other peculiarities present themselves, such as the small quantity of chlorine and of sesquioxide of iron, and the large quantity of carbonic acid contained in the ash of coffee.

The three most important constituents of the coffee-berry are, the *volatile oil*, called *caffeone;* the *caffeic acid*, analogous to the tannin of tea; and the *caffeine*, identical with the theine of tea. We shall make a few observations on each of these constituents.

The properties of coffee seed are much altered by roasting: the principal products of torrefaction are *a brown bitter principle*, derived principally from the conversion of the sugar into caramel, and *the aromatic oil*, called *caffeone.*

The properties of the infusion of the roasted coffee seeds are thus summed up by Pereira:—

"Roasted coffee possesses powerfully anti-soporific properties: hence its use as a drink by those who desire nocturnal study, and as an antidote to counteract the effects of opium and other narcotics, and to relieve intoxication. In those unaccustomed to its use, it is apt to occasion thirst and constipation. On some persons it acts as a slight purgative. It is occasionally useful in relieving headache, especially the form called nervous. It has also been employed ,as a febrifuge in intermittents, as a stomachic in some forms of dyspepsia and as a stimulant to the cerebro-spinal system in some nervous disorders. Flayer, Dr. Percival, and others have used it in spasmodic asthma; and Laennec says, 'I have myself seen several cases in which coffee was really useful. The immoderate use of coffee is said to produce nervous symptoms, such as anxiety, tremor, disordered vision, palpitation and feverishness."* Coffee is also supposed to counteract the tendency to the formation of gravel and stone.

The properties and effects of coffee are thus described by Professor Johnston:—

"It exhilarates, arouses, and keeps awake; it counteracts the stupor occasioned by fatigue, by disease, or by opium; it allays hunger to a certain extent, gives to the weary increased strength and vigour, and imparts a feeling of comfort and repose. Its physiological effects upon the system, so far as they have been investigated, appear to be, that while it makes the brain more active, it soothes the body generally, makes the change and waste of matter slower, and the demand for food in consequence less. All these effects it owes to the conjoined action of three ingredients, very similar to those contained in tea."

When roasted coffee is distilled with water, the *volatile aromatic oil* or *caffeone* passes over, and by drinking the oil and water together its effects may be ascertained.

When the quantity of oil obtained from two ounces of coffee was taken in a day, it was found to produce an agreeable excitement and gentle perspiration, to dispel the sensation of hunger, and to move the bowels. "In its exhilarating action upon the brain, it affects the imagination less than the reasoning powers." —*Johnston*.

When the dose of oil was doubled, violent perspiration comes on, with sleeplessness and symptoms of congestion.

Lehmann, by a series of careful observations and experiments on the urine, ascertained that it exercised an effect equal to that of caffeine in retarding the waste of the tissues.

The raw coffee seeds contain about 5 per cent. of an astringent acid, —the caffeic or caffeo-tannic,—which differs from ordinary tannic acid in that it does not blacken a solution of iron, as the infusion of tea does, but renders it green, and does not precipitate gelatine from its solution. This acid, although changed somewhat by the roasting, yet retains to some extent its astringent properties. "Chemists generally are disposed to refer the flavour and peculiar properties of coffee as a beverage more to its acid—the *caffeic acid* (particularly after that substance is modified in its properties by roasting) than any other constituent." — *Graham and Stenhouse.*

Caffeic acid, like the acid of the cinchona barks—kinic acid, yields kinone when the syrupy extract of coffee is mixed in a retort with about four times its weight of binoxide of manganese and one pint of sulphuric acid, diluted with an equal quantity of water, and the mixture is subjected to distillation. The kinone passes over into the receiver in the form of yellow crystals, which adhere to the neck and sides of the retort, as well as a bright yellow liquid containing kinone with much formic acid. Kinone is distinguished by its volatility and acrid odour, resembling that of chlorine. With ammonia the solution of kinone gives a sepia black colour, converted into reddish-brown by sulphuretted hydrogen. It is discharged by sulphurous acid.

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* Materia Medica, vol. ii. p. 1605., 3rd edition.

The astringent acid in coffee is much less than in tea, and hence it does not retard, to the same extent, the action of the bowels, especially when its operation is counteracted by the volatile aromatic oil, which exerts an aperient tendency.

Caffeine is a weak alkaloid of a white colour, crystallises in long silky needles, fusible, volatile, and soluble in water, alcohol, and ether. Its aqueous solution is precipitated by tannic acid.

The proportion of caffeine obtained in five experiments, made by Messrs. Graham and Stenhouse, upon different samples of coffee, was as follows :—

Caffeine in Raw Coffee.

Native Ceylon - - -	0·80
„ „ - - -	0·80
„ „ - - -	1·01
Plantation Ceylon - - -	0·54
„ „ - - -	0·83

The proportion of the analogous principle in tea—theine—is usually over 2 per cent; that is, tea contains on the average fully twice as much of this alkaloid as coffee.

"By rubbing common roasted coffee in a mortar, with a fifth of its weight of slaked lime, and then boiling the mixture in alcohol, about ½ per cent of theine may be readily extracted. Weight for weight, therefore, tea yields about twice at much theine as roasted coffee does to the water in which it is infused. But as we generally use a greater weight of coffee than we do of tea in preparing our beverages, a cup of coffee of ordinary strength will probably contain as much theine as a cup of ordinary English tea. A cup of strong French coffee will contain twice as much caffeine as a cup of weak French tea."—*Johnston.*[*]

The action of caffeine is nearly identical with that of theine, the operation of which on the system has already been described, *vide* p. 73., *et sequitur.*

We meet with, in Pereira's "Materia Medica,"[†] the following observations in relation to the properties of caffeine :—

"Mulder gave a grain of it to a rabbit; the animal ate but little the next day, and aborted the day after. Liebig has suggested that it probably contributes to the formation of taurine, the nitrogenised constituent of bile. According to Lehmann[‡], caffeine in doses of from 2 to 10 grains causes violent excitement of the vascular and nervous systems—palpitations of the heart; extraordinary frequency, irregularity, and often intermission, of pulse; oppression of the chest, pains in the head, confusion of the senses, singing in the ears, scintillations before the eyes, sleeplessness, and delirium. In all cases an augmentation was found in the amount of urea secreted."

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[*] Chemistry of Common Life, p. 208.

[†] Vol. ii. p. 1605., 3rd edition.

[‡] Physiological Chemistry, translated by D. Day, vol. i. p. 138. Cavendish Society, 1851.

Extraction of Caffeine.—The following is the process adopted for the extraction of caffeine by Messrs. Graham and Stenhouse:—

The raw coffee was ground fine, having been previously well dried at 212° F. to facilitate that operation. A decoction was then made of 1000 grains, by the repeated application of boiling water, so as to exhaust the coffee of all soluble matter. The solution was concentrated a little by evaporation. The acid of the coffee and certain other substances were now entirely precipitated by the addition, first, of the neutral acetate of lead, and then of the subacetate of lead. These insoluble matters were removed from the liquid by filtration. The excess of lead in solution was then thrown down by means of hydrosulphuric acid. The liquid, after this preparation, was evaporated to dryness, and the dry matter left was exhausted by means of strong spirits of wine (Sp. Gr. 0·840). The alcoholic solution was concentrated by evaporation, and allowed to stand in a nearly syrupy state for about ten days, in order to crystallise. The crystals, which are caffeine, were collected upon a small filter, and compressed powerfully to remove the mother liquor. These crystals were re-dissolved in a small quantity of water; the solution evaporated and crystallised anew. It gave almost nothing but caffeine, in long silky white needles, with little or no colour.

When it is merely desired to extract caffeine from raw or roasted coffee without regard to quantity, the general process for the extraction of organic bases, by means of ether, suffices. Lime is added to the infusion of coffee, which is then evaporated to dryness upon a water-bath. The extract may be divided by means of clean sand, and then agitated with ether. The caffeine crystallises as the ether evaporates, or it may be re-dissolved in water, and crystallised again. "We believe," write Messrs. Graham and Stenhouse, "that the caffeine from 10 per cent. of coffee in a mixture might be extracted, in sufficient quantity for its identification, by the preceding simple process. Caffeine, when once obtained, is fully recognised by its easy sublimation, and also by its action with nitric acid, in which it resembles uric acid. When the solution of caffeine in nitric acid is evaporated to dryness, and exposed to ammoniacal gas, it is covered by a pink blush, like murexide."

The coffee seed likewise contains about 13 per cent. of *gluten*, which, being for the most part insoluble in boiling water, is contained in the coffee grounds. In some countries the grounds are drank as well as the coffee.

The following analyses show the comparative and average composition of the unroasted coffee-berry and the tea-leaf, as imported into Europe:—

	Tea. Mulder.	*Coffee.* Payen.
Water	5	12
Gum and sugar	21	15½
Gluten	25	13
Theine	½	¾
Fat and volatile oil	4	13
Tannic acid	15	5
Woody fibre	24	34
Ash	5½	6¾
	100	100

The quantity of coffee extractive obtained from the coffee seed by water, differs very much in different samples,—a difference not explained by the extent of roasting of the seeds. The addition of an alkali—as soda—to the water, increases the amount of extract, and ensures a stronger infusion.

Structure of the Coffee Seed.

Two parts are to be discriminated in the coffee-berry—the substance of the berry, and the testa, or investment by which it is surrounded.

The *berry*, previous to roasting, and even after it has been soaked for a long time in water, is hard and tough, in which respect it differs from all those substances which enter into the adulteration of coffee, and which become softened by immersion in cold water; the hardness is even retained subsequently to the charring, and is so great, that by this character alone the fragments of the ground and roasted coffee-berry may be readily distinguished from those of chicory.

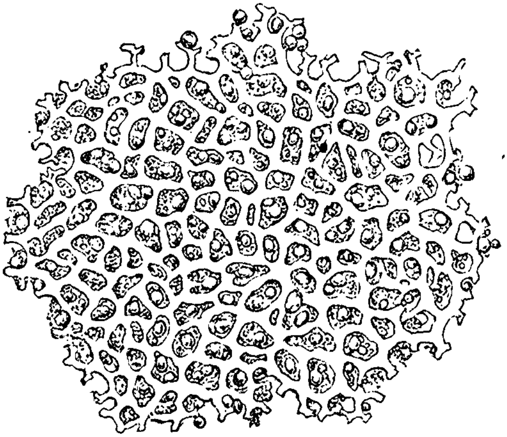
It consists of an assemblage of vesicles or cells of an *angular* form, which adhere so firmly together that they break up into pieces rather than separate into distinct and perfect cells. The cavities of the cells include, in the form of little drops, a considerable quantity of aromatic volatile oil, on the presence of which the fragrance and many of the active principles of the berry mainly depend. *Fig.* 22.

The *testa*, or investing membrane, presents a structure very distinct from that of the substance of the berry itself, and when once seen it cannot be confounded with any other tissue which has yet been observed entering into the adulteration of coffee: it is made up principally of elongated and adherent cells, forming a single layer, and having oblique markings upon their surfaces; these cells rest upon another thin membrane which presents an indistinct fibrous structure. Between the berry and its covering some essential oil is generally present. *Fig.* 23.

The quantity of this membrane present in a broken and divided state in any sample affords, therefore, some clue to the amount of coffee contained in it.

It has been proposed to deprive the berry of this membrane, and a patent has actually been taken out for this purpose—a process of somewhat doubtful utility, because the removal of this tissue cannot be effected without the loss of the greater part of the essential oil lying between it and the berry, and usually adherent to the former. In the act of roasting, however, more or less of this membrane becomes separated from the berry, when it is termed by the roasters "flights."

Fig. 22.

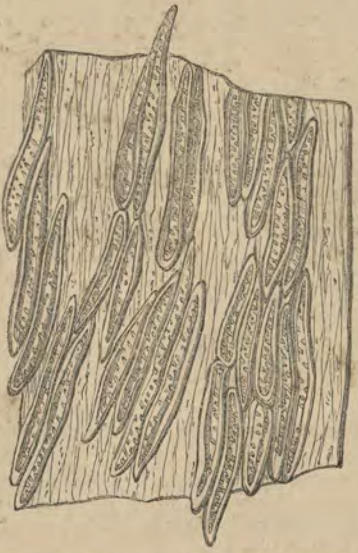


Section of UNROASTED COFFEE BERRY, showing the size and form of the cells, as well as the drops of oil contained within their cavities. Drawn with the Camera Lucida, and magnified 140 diameters.

In the groove which runs along each berry, a few small vessels, each formed of a single and continuous spiral thread, are usually to be met with; it is impossible, however, to confound these with the ducts hereafter to be described, and which occur in certain other vegetable tissues.

Now the roasting of the berry does not alter its structure; the tissues are indeed partially charred, but they still preserve their chief characteristics. The essential oil, however, is no longer visible in the cells in the form of minute drops or spherules. This has, in part, been dissipated by the heat employed in the process of roasting, and in part is more generally diffused throughout the cavities of the cells; that it is not entirely dissipated and destroyed is evident from the fact, that in ground roasted coffee, diffused in a little water, the oil may be readily detected in considerable quantity in a partially fused state, in little masses of irregular size and form. *Fig.* 24.

Fig. 23.



A portion of the INVESTING MEMBRANE of the coffee berry, showing its structure. Drawn with the Camera Lucida, and magnified 140 diameters.

ON THE ADULTERATION OF COFFEE.

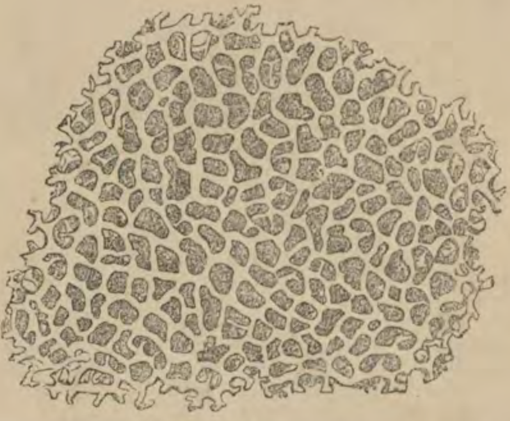
There are few articles of consumption more subject to extensive adulteration, and this of the grossest kind, than coffee.

At the time when we first directed our attention to the adulteration of coffee, about six years since, it was scarcely possible to procure a sample of ground coffee, no matter what the price paid for it or where it was purchased, that was not largely adulterated.

Adulteration with Chicory.—The most prevalent adulteration of coffee is with chicory. In nearly all the samples then examined chicory formed a large proportion of the article, while in many instances it consisted almost entirely of chicory. At the present time coffee is still much adulterated with chicory, while the compound sold with the labels now prescribed by the law, "This is a mixture of chicory and coffee," often consists of little else than chicory.

Even the grinding of coffee in the presence of the purchaser affords no certain guarantee for the genuineness of the article, as not unfrequently the grocer adroitly conveys into the mill, from a box placed close to it, as many chicory nibs as he pleases, and which, owing to their resemblance in size and colour to coffee berries, are not readily distinguished at a short distance.

Fig. 24.

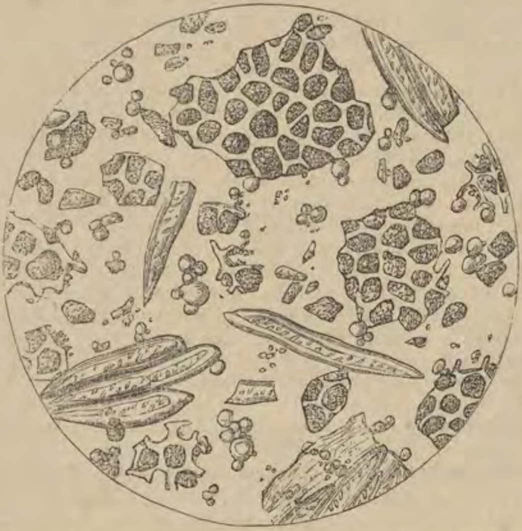


A fragment of ROASTED COFFEE. Drawn with the Camera Lucida, and magnified 140 diameters.

Even whole roasted coffee has been adulterated with chicory: in this case the berries are compressed into the form of coffee berries. In 1850, Messrs. Duckworth, of Liverpool, took out a patent for moulding chicory into the shape of berries: they appear to have been induced to do so in consequence of the existence in 1850 of a Treasury minute, which allowed of the sale of chicory mixed with coffee without any restriction.

It has been loudly and repeatedly urged in extenuation of this adulteration, especially by grocers, that the addition of chicory to coffee is a great improvement. There are undoubtedly some few persons who consider that it does improve the flavour by making the infusion more bitter, although that is not our opinion, nor that of the great majority of persons. We believe, moreover, that the taste of those persons who really prefer the mixture, has been vitiated, and that had they the opportunity of partaking of well prepared and unadulterated coffee, they would not be long before they acknowledged the infinite superiority of the genuine beverage even as a matter of taste. When the relative properties of coffee and chicory are taken into account, no doubt whatever can be entertained as to which is the superior article. The composition and properties of chicory will be shortly considered.

Fig. 25.



This engraving exhibits the structure and characters of *genuine ground* COFFEE.

Again, it has been asserted that in France and other continental countries the use of chicory is almost *universal*. We have taken considerable pains, when abroad, to ascertain how far this statement is correct, and we will now state with what results. We found that in all the good hotels in France and Germany the coffee served up was genuine, and did not contain a particle of chicory; also, that chicory was not mixed with coffee in the houses of the wealthy, but that it was largely employed, either separately or mixed with coffee, by poor persons, and amongst the domestics, not because it was considered to be an improvement, but on the score of economy, chicory costing about 2*d*. or 3*d*. per lb., and coffee four or five times as much. This is the real secret of the use of chicory abroad, and not because of any preference, or that it improves the flavour of coffee. Where money is not an object, and where the best coffee is required, chicory is but seldom had recourse to. The practice, then, abroad is the very reverse of what has been asserted, and it affords no countenance to the statement that coffee is improved by the use of chicory.

Again, if really an improvement, as some persons consider, it would only be so when employed in certain proportions. Now in the ground coffee sold in the shops in this country, it is met with in every proportion, it constituting sometimes over 90 per cent. of the article. The allegation that chicory improved the flavour of coffee, would not warrant its use to anything like that extent.

It cannot therefore be doubted for a moment that the real cause of the extensive employment of chicory in this country, is that by its means grocers are enabled to enhance greatly their profits.

But we will suppose, for sake of argument, that it is a decided improvement; yet this does not justify the sale of a mixture of chicory and coffee, as and under the name of coffee, coffee frequently forming but a small per-centage of the article. Such a mixture, if permitted at all, should not only be sold labelled as a mixture, but the proportions of each ingredient should be specified.

We consider that few persons will be disposed to question the right of the purchaser, when he enters a shop and asks for a particular article, to expect that he will be supplied with the article he demands; and that if he asks for coffee he will be supplied with coffee, and not with a mixture of two articles in the most uncertain and indefinite proportions.

Let the two articles, therefore, be sold separately, and let them be purchased by the public at their respective prices. This is the simple and straightforward course to pursue, and is that which is adopted on the continent.

At length, and after years of labour and argument, the government has been driven to acknowledge the impropriety of permitting chicory to be sold under the name of coffee, and frequently also at the price of that article; and within the last two years or so, it has been required that the mixed article should be sold labelled "This is a mixture of Chicory and Coffee."

But this regulation by no means fulfils the requirements of justice, because the mixture is often palmed off when coffee only is asked for, and because the proportions of the ingredients are not stated.

There is one circumstance which should be particularly remembered in considering the question of the adulteration of coffee with chicory, namely, the differences, chemical and physiological, which exist between the two articles.

Coffee and Chicory contrasted.—Coffee is the seed of a plant, and it contains essential oil or caffeone, caffeic acid, and a peculiar principle termed caffeine; each of these constituents possesses different and highly important properties, upon which the value of coffee mainly depends.

Chicory is the root of a plant belonging to the family of the dandelions. It contains no essential oil, tannic acid, or alkaloid analogous to that of coffee. The chief constituents of which it is made up when roasted, are a little gum, sugar partly burned and reduced to caramel, colouring matter, and insoluble vegetable tissue.

Between the two articles, therefore, there is no analogy whatever; and in proportion as the strength of coffee is reduced by admixture with chicory, so are the active properties of coffee diminished.

It is to the presence of constituents similar to those of coffee that tea, as has already been pointed out, and also cocoa, owe their active properties, and which has led to the almost universal employment of either tea, coffee, or cocoa over nearly the whole of the inhabited portions of the globe.

But coffee is subject to adulteration with a variety of other articles besides chicory.

Adulteration with Roasted Grain, Roots, Acorns, Sawdust, &c. Thus it is not unfrequently adulterated with *roasted grain*, principally *wheat*, and also with *scorched peas* and *beans* ground into powder. Less commonly *roasted carrots*, *mangold-wurzel*, *rye*, and *acorns* have been employed, and even woody fibre, or *sawdust*, especially *mahogany sawdust*. We have ourselves detected sawdust on two occasions, and the other substances mentioned in several instances.

Other articles which have been forwarded to us, and which it has been stated have been used in the adulteration of coffee, are, first, an article termed "*coffina*," *oak-bark tan*, *exhausted tan* termed *croats*, and *baked horses' livers*.

The article on which the name of coffina was bestowed, was introduced into this country in 1851, and was expressly made for the adulteration of coffee. It was described as the seed of a Turkish plant, which was found to be highly nutritious. On subjecting it to examination with the microscope, it was ascertained to consist of the roasted seeds of some leguminous plant, probably a lentil.

Of this article we were informed that no less than eighty tons were offered for sale by a Scotch house at about 12*l.* per ton; that is, at about 1¼*d.* per lb. On this single transaction the revenue would be defrauded of no less a sum than 4480*l.*, and the public of at least four times that amount, namely 18,000*l.*

The importation of about one hundred tons of lupin seed from Egypt into Glasgow, has led, writes a correspondent, to the conjecture that this coffina was made from it, — a conjecture most probably correct, since the structures met with in coffina exactly resemble those of lupin seed.

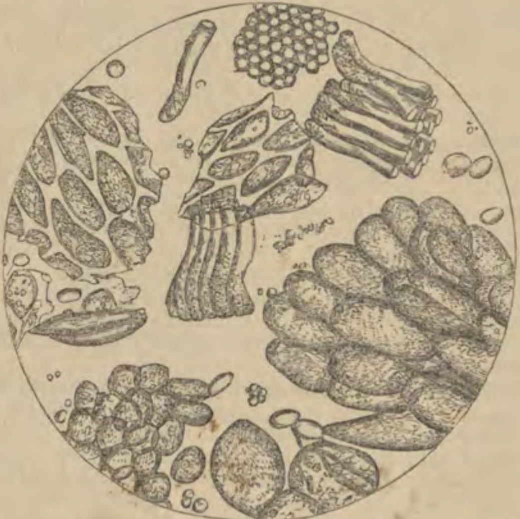
The same firm to which the coffina was sent was offered, at about the same time, five hundred tons of foreign acorns at 5*l.* per ton, or less than three farthings per lb. Should these have found a purchaser, the revenue would have been cheated to the extent of 28,000*l.*, and the public to that of 112,000*l.* The acorns, when roasted and powdered, were intended to be used in the adulteration of coffee.

In a little work, published some four or five years since, entitled

"Coffee as it is and as it ought to be," the following observations occur in reference to the use of baked horses' and bullocks' livers: —

"In various parts of the metropolis, but more especially in the east, are to be found liver bakers. These men take the livers of oxen and horses, bake them, and grind them into a powder which they sell to the low-priced coffee-shop keepers at from 4*d.* to 6*d.* per lb., horses' liver coffee bearing the highest price." It may be known, the writer states, "by allowing the coffee to stand until cold, when a thick pellicle or skin will be found upon the top. It goes further than coffee, and is generally mixed with coffee and other vegetable imitations of coffee."

Fig. 26.



This engraving exhibits the several structures detected in a sample of "COFFINA." Drawn with the Camera Lucida, and magnified 140 diameters.

The adulteration of coffee in some cases alters and reduces so greatly the colour and appearance of the article, as well as of the infusion made from it, that the use of colouring matters is frequently necessitated.

One of these is *burnt sugar*, familiarly known in the grocery trade and by coffee-shop keepers as Black Jack.

It is sold to the coffee-shop keepers usually in tin canisters at 1*s.* per lb.: it is sometimes denominated the coffee refiner; it is, however, rather a colouring agent, and it is employed to impart colour and bitterness to beverages made from adulterated coffee, these being the qualities which in the eyes of superficial observers denote strength and goodness.

Sugar is sometimes added to coffee berries while undergoing the process of roasting, and, being then burned, is converted into a coffee colourer.

Another article used to give increased colour to adulterated ground coffee is *Venetian red*, or some other analogous ferruginous earth. We have not only ourselves obtained repeated evidence of the use of this substance, but we shall presently quote a passage from the writings of the late Dr. Pereira in reference to its employment.

In the latter part of 1850 the author read a communication to the Botanical Society of London on the adulteration of coffee; that is some months before the publication of the first of his Reports in "The Lancet" on adulteration. In this the author described, for the first time, the results at which he had been enabled to arrive by the examination of coffee by means of the microscope. These results were as follow: —

Results of the Microscopical Examination of thirty-four different Coffees of all Qualities and Prices, and sold under the following attractive Titles:

Coffees of High Price.

1. *Finest Mocha Coffee.* No adulteration.
2. *Noted Old Mocha.* No adulteration.
3. *Finest Jamaica Coffee.* No adulteration.
4. *Rich Old Mocha.* Of chicory, a good deal.
5. *Best Old Mocha.* A little chicory.
6. *Fine Old Turkey Coffee.* Much chicory.
7. *Very Fine Mocha.* Much chicory.
8. *Genuine Old Mocha.* A little chicory.
9. *Finest Turkey Coffee.* Contains chicory.
10. *Celebrated Old Mocha.* A good deal of chicory.

Coffees of Medium Price.

11. *Costa Rica Coffee.* Nearly one-half chicory.
12. *Fine Jamaica Coffee.* Contains a considerable quantity of roasted corn.
13. *Delicious Coffee.* Roasted beans and chicory, forming about one-third of the article.
14. *Plantation Coffee.* Of roasted corn much, with some chicory, both together forming not less than a third of the sample.
15. *Finest Turkey Coffee.* Much chicory, and some roasted corn; very little coffee.
16. *Celebrated Jamaica.* Very little coffee, principally chicory.

17. *Finest Berbice Coffee.* About one-half coffee, much chicory, and some wheat.
18. *Splendid Turkey Coffee.* About one-half coffee, the rest chicory.
19. *Fine Plantation Coffee.* One-third coffee, the rest chicory, with a little roasted corn.
20. *Beautiful Jamaica Coffee.* Two-thirds coffee, the rest chicory, with a little corn.
21. *Finest Java Coffee.* Half coffee, much roasted corn, with a little chicory.
22. *Superior Plantation Coffee.* Three-fourths coffee, the remainder chicory.

Coffees of Low Price.

23. *Fine Mountain Coffee.* Four-fifths coffee, one-fifth chicory.
24. *Parisian Coffee.* Principally chicory and corn; very little coffee.
25. *Superb Coffee.* The principal part corn and chicory; very little coffee.
26. *Rich drinking Coffee.* One-third coffee, the rest chicory, with some roasted corn.
27. *Very excellent Coffee.* One-half coffee, the other mostly chicory.
28. *Delicious Family Coffee.* One-fourth coffee, three-fourths chicory.
29. *Fine Ceylon Coffee.* Very little coffee, a great deal of chicory, with some roasted corn.
30. *Fine Java Coffee.* Much chicory and some roasted potato; very little coffee.
31. *Coffee as in France.* Principally chicory.
32. *Very excellent Coffee.* Principally chicory.
33. *Fine Plantation Ceylon.* Nearly all chicory; very little coffee.
34. *Delicious drinking Coffee.* A large quantity of chicory, and much roasted corn.

From an examination of this Table it appears —

1st. That of the thirty-four coffees, *thirty-one* were adulterated.
2nd. That chicory was present in *thirty-one* of the samples.
3rd. Roasted corn in *twelve.*
4th. Beans and potato flour, each in *one* sample.
5th. That in *sixteen* cases the adulteration consisted of chicory only.
6th. That in the remaining *fifteen* samples, the adulteration consisted of chicory, and either roasted corn, beans, or potatoes.
7th. That in many instances the quantity of coffee present was very small; while in others, it formed not more than one-fifth, fourth, third, half, and so on of the whole article.

We are satisfied that the gross aggregate of the adulterations detected did not amount to less than one-third of the entire bulk of the quantity purchased. Now, on referring to the Revenue Returns, we find that the sum derived from the duty on coffee for 1855 was 44,848*l.* 11*s.* 9*d.*, an amount which we have no hesitation in saying might have been enormously increased by vigilance in the detection of the adulteration of this important article, and by punishment of the fraud when detected.

Since the date referred to, we have examined some hundreds of samples of ground coffee.* Until within the last year or two, we always found a very large proportion of the samples to be adulterated. More recently, however, the condition of the article has greatly improved; the grosser adulterations, — whatever may be the state of things in the provinces, — so far as the metropolis is concerned, are now much less frequently practised: the principal adulteration is that with chicory, which is still mixed with coffee, and sold without the prescribed label as coffee. This improved state of things is undoubtedly due to the repeated exposures made within the last four or five years. But is it not perfectly certain, if these exposures were to cease, that matters would soon become even worse than before, and that the scandalous and nefarious practices which once prevailed in the adulteration of this article would speedily be rife again?

The adulterations by means of roasted corn, beans, coffee colourer, and Venetian red are altogether indefensible, since the only thing in common between most of these and coffee is the colour which they yield on infusion or decoction.

Some years since, roasted corn, principally rye, was largely sold, and employed to make a beverage, which, by a fiction, was dignified by the name of coffee; the chief argument, independent of price, urged in favour of it, was its supposed nutritive properties.

When it is recollected that the starch of roasted corn is in part reduced to the condition of charcoal, it will at once be perceived that its nutritive qualities cannot be very great, and that a single mouthful of wholesome bread contains more nourishment than a dozen cups of a beverage made from roasted corn.

Although "roasted corn" is now no longer sold openly, yet, as we have just seen, the grocer has not failed to avail himself of it for his own benefit, but to the great disadvantage of the public.

The adulteration of coffee by substances so cheap and, for the purpose to which they are applied, worthless as these, is a gross fraud, requiring emphatic condemnation, and, when ascertained to be practised, meriting exposure and punishment.

On the Detection of the Adulterations of Coffee.

The means to be resorted to for the detection of the adulterations of coffee, are of three kinds: namely, certain physical characters and appearances presented by adulterated samples; the microscope;

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* The particulars of these examinations are recorded in "Food and its Adulterations."

and chemistry. By the first, we ascertain in some cases the general fact whether the sample is adulterated or not; and by the others, especially by the microscope, we learn the nature of the particular adulteration or adulterations practised.

The first means consist in noticing whether the sample in the mass cakes or coheres, whether it floats in water or not, and the colour of the infusion.

If the ground coffee cakes in the paper in which it is folded or when pressed between the fingers, there is good reason for believing that it is adulterated, most probably with chicory.

If, when a few pinches of the suspected coffee are placed upon some water in a wine-glass, part floats and part sinks, there is reason to believe that it is adulterated; it may be either with chicory, roasted corn, or some other analogous substances. The coffee does not imbibe the water, but floats on the surface, while the other substances absorb the water, and gradually subside to the bottom to a greater or less extent. Usually, however, part of the coffee subsides with the chicory, and a portion of the latter remains on the surface with the coffee; and after the lapse of a short time, in general, both coffee and chicory fall to the bottom.

Again, if the cold water to which a portion of ground coffee has been added, quickly becomes deeply coloured, it is an evidence of the presence of some roasted vegetable substance or burnt sugar; for when coffee is added to water, it becomes scarcely coloured for some time.

Lastly, if in a few grains of coffee, spread out on a piece of glass and moistened with a few drops of water, we are enabled to pick out, by means of a needle, minute pieces of substance of a soft consistence, the coffee is doubtless adulterated; for the particles of the coffee seed are hard and resisting, and do not become soft even after prolonged immersion in water.

When, therefore, any sample cakes into a mass, quickly furnishes to cold water a deep-coloured solution, or is found to contain, when moistened with water, soft particles like those of bread-crumb, there can be no question as to the existence of adulteration.

The general characters of genuine ground coffee are, therefore, the reverse of the above.

By these general means, and without having recourse to science, the observer is often enabled to state whether any sample of coffee is adulterated or not; but in order to determine the character of the adulteration practised, we must employ either the microscope or chemistry. In the case of coffee, by far the most important information is furnished by the microscope; indeed, chemistry affords no certain means for the identification of the majority of the vegetable substances employed in the adulteration of coffee, and did it do so, it would hardly be required, since these may be so readily detected by the microscope.

Messrs. Graham, Stenhouse, and Campbell have instituted some special chemical inquiries on the mode of detecting vegetable substances mixed with coffee: these will be found referred to, at some length, under the article Chicory.

The result of these investigations is, that it is easy enough to ascertain by means of chemistry the general fact of adulteration, but that it is not possible by the same means to determine the nature of the adulteration practised, even that with chicory.

The general fact of adulteration may be determined in a variety of ways; as, in addition to the colour of the infusion and by its specific gravity, by the quantity of *sugar* contained in it, and *the composition of the ash.*

The quantity of sugar in roasted coffee rarely exceeds 1·12 per cent., while in the saccharine roots used in the adulteration of coffee — as those of roasted chicory, carrot, parsnip, and mangold-wurzel — it varies from 9 to 18 per cent.

The most distinctive peculiarity of the composition of the ash of coffee, is the small quantity of *silica* contained in it: "the presence," state Messrs. Graham and Stenhouse, "of 1 per cent or upwards of silica in the ashes of coffee is a proof of adulteration; that the adulterating substances which increase the proportion of silica most considerably are oats and barley, then chicory and dandelion, which are followed by rye and wheat; but turnips and carrots would produce a small and less decisive effect."

Determination of the Sugar in adulterated Coffee.

The following process may be pursued for the determination of the sugar:—Two thousand grains of the article are to be infused in three separate pints of water, the first cold, and the second and third warm. To this infusion add about one-eighth part of brewer's yeast, weighed after being dried by pressure in a calico bag. The fermentation is to be continued for forty-eight hours, the infusion being kept at a temperature of from 80 to 90°Fahr. The liquor is then to be distilled twice, the alcoholic solution weighed, and its specific gravity taken at a temperature of 60° Fahr. When the quantity of sugar and the amount of alcohol developed is very small, recourse may be had to the fermentation test.

The articles which have been detected entering into the adulteration of ground coffee, have already been enumerated: they are roots of different kinds, particularly chicory and mangold-wurzel; various farinaceous substances in the roasted and powdered state, as wheat flour, beans, and acorns, besides woody fibre or sawdust, burnt sugar, and Venetian red, or reddle.

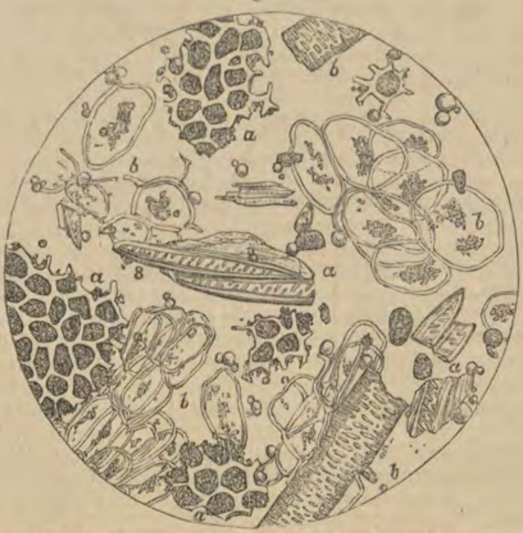
On the Detection of Chicory.—Some five or six years since, an outcry having arisen in consequence of the substitution to an enormous extent of chicory for coffee, and government being called upon to interfere, the question as to whether the presence of chicory in ground coffee was discoverable or not by means of science, was referred by the Chancellor of the Exchequer of the time to a commission of chemists.

These chemists reported, that "neither by chemistry nor by any other means was the admixture of chicory with coffee to be detected." This report was publicly quoted by Sir Charles Wood in the House of Commons, and on the strength of it the government refused to interfere in the prevention of the adulteration of coffee. Now at the same time the author showed, in the most conclusive manner, that nothing is more easy and certain than the detection of chicory in coffee by means of the microscope.

The structure of coffee has already been fully described; that of chicory will shortly be considered: it may be stated now, however, that it differs in every respect from coffee, in the rounded form and easy separability of its component cells, and in the presence of dotted ducts, and vasa lacticentia.

The differences will be sufficiently obvious on an examination of the following figure.

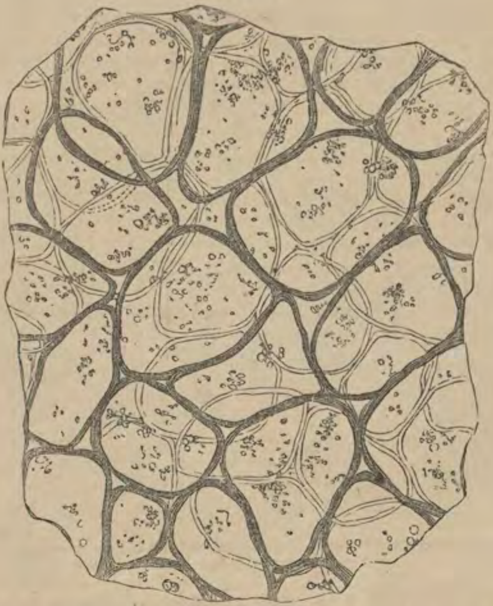
Fig. 27.



Shows the structures in a sample of COFFEE *adulterated with* CHICORY.
a a, coffee ; *b b*, chicory.

Detection of Mangold-Wurzel.—This root differs from chicory in the very much larger size of the cells, and in the absence of milk vessels or vasa lacticentia. *Figs.* 28. and 29.

Fig. 28.

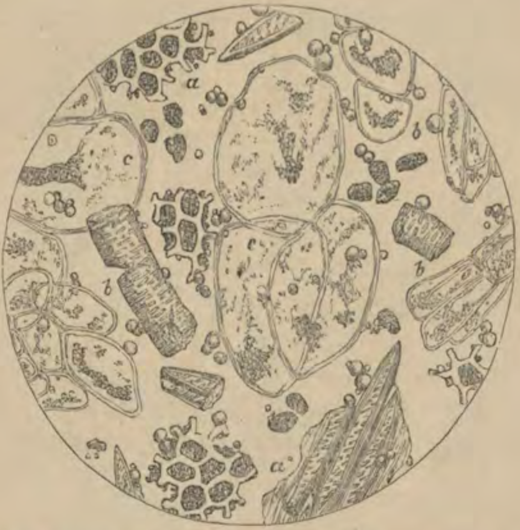


This figure exhibits the cells of which the root of MANGOLD-WURZEL is chiefly formed: it will be observed that they are several times larger than those of chicory root.

Detection of Carrot and Parsnip.—The tuber of carrot differs from chicory chiefly in the absence of milk vessels; that of parsnip in the absence of the same vessels, and in the presence in the cells of regularly formed starch corpuscles of small size.

On the Detection of Wheat Flour, &c.—It is generally stated that the presence of roasted corn or any other substance containing a large proportion of starch, may be detected by the blue colour produced on the addition of a solution of iodine to the cold decoction. We have not found this to be correct in all cases, for on adding iodine to decoctions of five different coffees ascertained to be adulterated with roasted corn, the liquids did not become blue, but almost black, with a tinge of brown or olive. This appears to arise from the obscuration of the blue colour developed by the iodine, by the rich brown colouring matter of the chicory—a proportion of which almost always accompanies the adulteration with corn. This test, however, is still very useful in some cases, although it does not often give rise to a colour which can be called blue. It should be known, also, that solution of iodine, added to a cold decoction of chicory root, deepens the colour very greatly: the increase of colour is never, however, so considerable as when flour is present.

Fig. 29.



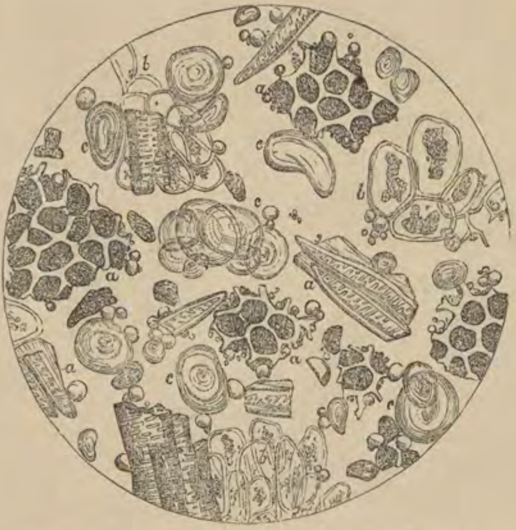
Shows the structures met with in *Coffee adulterated with* MANGOLD-WURZEL. *a a*, fragments of the coffee berry; *b b*, cells of chicory; *c c*, ditto of mangold-wurzel.

It is to be further observed that no exact idea can be formed in this way of the quantity of starch contained in the adulterated coffee, because part, being charred, gives no reaction with iodine.

Supposing, however, that the presence of starch in coffee could be invariably detected by the iodine test, yet neither that test nor indeed all the resources of chemistry can furnish us with precise information as to the kind of starch employed. For this we must seek the aid afforded by the microscope.

The microscopical structure of wheat and certain other flours, will be found described under the heads Flour and Bread. They are distinguished chiefly by the characters of the starch corpuscles. It may be stated, generally, that those of wheat consist of rounded and flattened discs of various sizes. The appearances which they present are

Fig. 30.



Sample of *Coffee adulterated with both* CHICORY *and roasted* WHEAT.
a a, coffee ; *b b*, chicory ; *c c*, wheat flour.

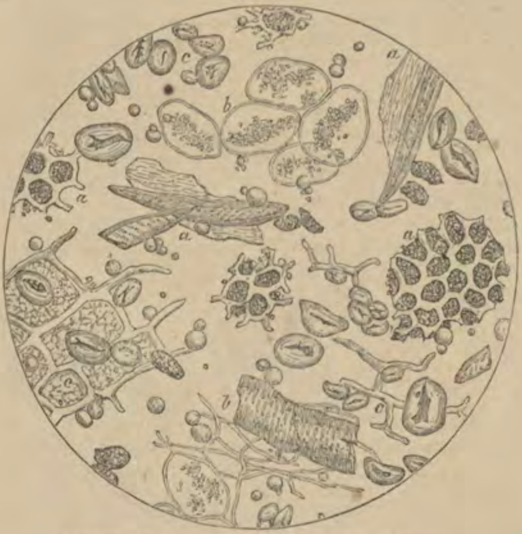
very distinct from the cells of either coffee or chicory, as will be seen by the annexed engraving. *Fig*. 30.

On the Detection of Bean Flour.—The substance of the seed of the bean is made up of cells, each of which contains several starch corpuscles. The form and characters of these are very distinctive; they are for the most part either oval or uniform, with a central cavity of an elongated form, and from the margin of which short rays or processes may be seen radiating. So long in some of the granules of medium size is this cavity, that they appear to be completely bisected; occasionally a few strongly marked concentric rings are visible. Some of these characters are exhibited in *fig*. 31.

On the Detection of Roasted and Ground Acorn.—The presence of this substance is distinguished by the form and sizes of the starch corpuscles, which form so large a part of the acorn. *fig*. 32.

On the Detection of Sawdust.—The detection of sawdust, especially mahogany sawdust, is extremely easy; the presence of woody fibre of some kind or other is sure to be discovered when the suspected samples come — as they always ought — to be examined with the microscope. The presence of sawdust having been thus ascertained, a pound or so of the coffee should be spread out on a slip of glass, and moistened with water, when the fragments of woody fibre may generally be picked out by means of a needle; they should then be subjected to a more careful microscopical scrutiny.

Fig. 31.



Coffee adulterated with both CHICORY *and roasted* BEANS.
a a, coffee ; *b b*, chicory ; *c c*, roasted bean flour.

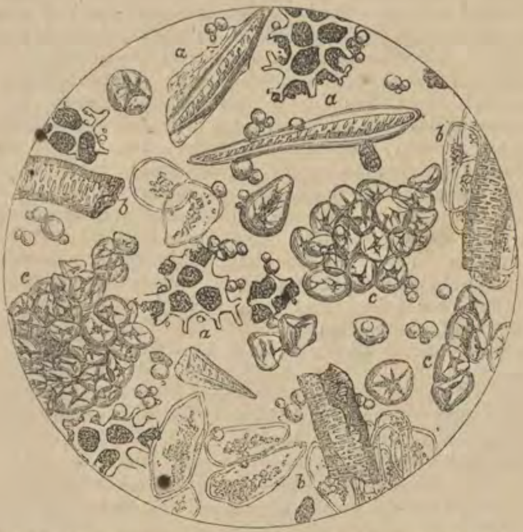
The woody fibre of plants, like the cellulose, starch corpuscles, and vessels, frequently possesses distinctive characters, visible under the microscope, by which the plant or tree furnishing it may be identified.

In the case of mahogany sawdust the identification is easy enough; the compactness of the little masses of fibre, the strong cross markings, and the colour are sufficiently characteristic.

It should be remembered that chicory, especially the older roots, contains a small proportion of woody fibre, so that care must be exercised not to confound this fibre with extraneous woody fibre or sawdust introduced for the purpose of adulteration. If the quantity of fibre present be very small, and it agrees with that of chicory in its structure as seen under the microscope, there can be little doubt but that the fibre belongs to the root of chicory.

On the Detection of Caramel or Burnt Sugar. — When the water added to any sample of ground coffee becomes deeply and quickly coloured, and when on examination with the microscope it is ascertained

Fig. 32.



Sample of *Coffee adulterated with ground* ACORN. *a a*, coffee; *b b*, chicory; *c c*, acorn.

that no foreign vegetable is present, there will be good reason for supposing that it contains burnt sugar.

Again, when shining black particles are perceptible in the coffee, and these slowly dissolve in water, giving rise to a dark-coloured solution, it undoubtedly contains the substance in question. Sometimes, when the particles are too small to be discerned by the naked eye, they may be seen under the microscope, and their solution in water watched.

Again, the presence of burnt sugar may be detected by adopting the following process:—From a weighed quantity of dried coffee an infusion in cold water is to be prepared: this must be evaporated in a water-bath, dried, and tasted. If the extract be dark-coloured, brittle, and possess the bitter taste of burnt sugar, no doubt remains as to the presence of that substance.

We are unacquainted with any process by which the quantity of burnt sugar present can be accurately determined, seeing that the extract furnished by pure coffee varies very greatly, and that of adulterated coffee to a still more considerable extent; while also the composition of the burnt sugar is so much changed, that its amount cannot be determined in the same manner as grape sugar.

On the Detection of Venetian Red.—Sometimes when the Venetian red has been carelessly incorporated with the coffee, particles of it may be detected with the naked eye; but it is not often that it can be discovered in this way. The process to be adopted in ordinary cases is as follows:—A portion of the suspected coffee is to be incinerated, and the colour of the ash noted: if this be deeply coloured and of a rusty red or yellowish hue, then Venetian red, reddle, or some analogous earthy substance has been mixed with the coffee.

If we desire to form some opinion as to the amount of this present, the coffee must be dried in a water-bath, 500 grs. incinerated, and the ash weighed and analysed; the weight may be compared with that of the ash of genuine coffee, and the ash then tested quantitatively for iron, and, since the Venetian red is sometimes itself adulterated with chalk, for it also. The process for the quantitative estimation of iron will be found detailed at pp. 102. and 149., and that for chalk at p. 101.

It has thus been shown that coffee is liable to a large and scandalous amount of adulteration.

The duty on coffee is 4*d*. per lb. until April 5th, 1857. Thereafter 3*d*. per lb.

			Lbs.
Home consumption	1854	duty 3*d*.	37,471,014.
„	1855		35,876,287.
9 months of	1856		26,522,821.
„	1855		27,598,417.

Duty 4*d*. on and after April 21st, 1855.

CHICORY, AND ITS ADULTERATIONS.

Chicory, succory, or wild endive, *Cychorium Intybus*, belongs to the same natural family of plants as the dandelion, a very characteristic and familiar cognomen of which we refrain from mentioning. Like the dandelion, chicory is indigenous, and may be seen growing in various parts of the country, by the road or hedge side; it may be recognised by the compound character of its flowers, and their bright and beautiful blue colour. It blossoms in the months of August and September; and any person desiring to get a sight of this very notorious vegetable, may gratify his curiosity by a walk along the banks of the Thames, from Kew for about a mile or so in the direction of Richmond.

"This plant," says M'Culloch, "is found growing wild on calcareous soils of England, and in most countries of Europe. In its natural state the stem rises from one to three feet high, but when cultivated it shoots to the height of five or six feet. The root runs deep into the ground, and is white, and fleshy, and yields a milky juice. It is cultivated to some extent in this country as an herbage plant, its excellence in this respect having been strongly insisted upon by the late Arthur Young.

"But in Germany, and in some parts of the Netherlands and France, it is extensively cultivated for the sake of its root, which is used as a substitute for coffee.

When prepared on a large scale, the roots are partially dried and sold to the manufacturers of the article, who wash them, cut them in pieces, kiln-dry them, and grind them between fluted rollers into a powder.

"The powder has a striking resemblance to dark ground coffee, and a strong odour of liquorice. It has been extensively used in Prussia, Brunswick, and other parts of Germany, for several years; but as it wants the essential oil, and the rich aromatic flavour of coffee, it has little in common with the latter, except its colour, and has nothing to recommend it except its cheapness."

Notwithstanding that chicory "has nothing to recommend it except its cheapness," and that it is used exclusively to adulterate coffee, it has of late years been raised in great quantity in this country, in the counties of Surrey, Bedford, and York, owing to the very improper encouragement given by Government.

Large crops of chicory are grown in Yorkshire, in the neighbourhood, it is stated, of property belonging to a late Chancellor of the Exchequer; and it was this circumstance which led to the assertion that he was himself an extensive grower of the plant.

This statement has, however, been distinctly contradicted by the Chancellor in question, who, in making known the denial, refrained from any allusion to the circumstance which explains the origin of the report. We are not surprised that the charge should have been made, for it is only natural, when an individual pertinaciously follows a course opposed to reason and correct principles, that an endeavour should be made to account for conduct so singular, and that it should be imagined that some strong personal interest existed, whereby the course of proceeding adopted might be explained.

Foreign chicory is considered to be greatly superior to that of English growth, and is consequently much dearer.

The root is taken up just before the plant blossoms, and, when roasted, lard is added in the proportion of 2 lbs. of lard to 1 cwt. of the kiln-dried root. When ground and exposed to the air, chicory absorbs water readily, and becomes moist and clammy.

Analysis of Chicory.

Chicory root has been subjected to examination and analysis, by the author, and by Dr. Letheby at the author's request, in three conditions, namely:—

"1st. In its recent, or raw state.

"2nd. In the kiln-dried condition.

"3rd. In the roasted and powdered form, as it is used for the adulteration of coffee.

"The *raw root* furnishes a milky juice, which owes its opacity to the presence of an inert vegetable substance named Inuline. The juice is very bitter, and, when filtered and heated, it shows, by its turbidity, that it contains a small quantity of albumen.

"When macerated in cold water, it yields about 13 per cent. of solid matter or extractive, which gives to the solution a very bitter taste; alcohol also extracts this bitter constituent, and on evaporation it furnishes a gummy product, which is very similar in its properties to the bitter material of the dandelion root. Acetate of lead produces a copious precipitate in the liquid from the deposition of gum, vegetable acid, and colouring matter. By means of Fehling's test, it was found that the raw root contained 1·1 per cent of grape sugar or glucose.

"The *kiln-dried root* possesses all the characters of the preceding, but in a higher degree, for water extracts about 50 per cent. of solid matter; and the solution furnished to Fehling's test as much as 10·5 per cent. of sugar.

"Neither of these specimens exhibited the least trace of starch, but by boiling in water, filtering, and cooling, they yielded a small quantity of a white powder, which had all the characters of Inuline.

"The absence of starch in the state in which the root is ordinarily used is also conclusively shown by means of the microscope; and we find that the tissue contains abundance of cellulose, which, by the action of strong sulphuric acid, gives a product that renders iodine blue.

"The *roasted chicory root* yields from 45 to 65 per cent. of soluble extractive. Its solution in water is acid, and it does not possess the peculiar bitter taste of the raw root; but the taste of the liquid is more like that of burnt sugar. The copper test shows the presence of from 10 to 13 per cent. of sugar.

"The following analyses represent the per-centage composition of the root in its different conditions:—

	Raw Root.	Kiln-dried.
Hygroscopic moisture	77·0	15·0
Gummy matter (like pectine)	7·5	20·8
Glucose, or grape sugar	1·1	10·5
Bitter extractive	4·0	19·3
Fatty matter	0·6	1·9
Cellulose, inuline, and woody matter	9·0	29·5
Ash	0·8	3·0
	100·0	100·0

"The composition of the *roasted root* was as follows:—

	1st Specimen.	2nd Specimen.
Hygroscopic moisture	14·5	12·8
Gummy matter	9·5	14·9
Glucose	12·2	10·4
Matter like burnt sugar	29·1	24·4
Fatty matter	2·0	2·2
Brown or burnt woody matter	28·4	28·5
Ash	4·3	6·8
	100·0	100·0

"The *ash* of these had the following composition:—

	1st Specimen.	2nd Specimen.
Chloride of potassium	0·22	0·45
Sulphate of potash	0·97	0·98
Phosphate of potash	1·41	1·37
Ditto of magnesia	0·30	0·53
Ditto of lime	0·40	0·81
Carbonate of lime	0·10	0·26
Alumina and oxide of iron	0·20	0·20
Sand	0·70	2·20
	4·30	6·80

Messrs. Graham, Stenhouse, and Campbell * found in four samples of chicory, the following per-centages of grape sugar:—

	Raw.	Roasted.
Foreign chicory	23·76	11·98
Guernsey chicory	30·49	15·96
English chicory	35·23	17·98
Yorkshire chicory	32·06	9·86

The quantities of sugar in mangold-wurzel, carrots, turnips, parsnips, beet and dandelion roots were found to be nearly as great as in chicory, and hence the sugar present in it does not afford a means by which it may be distinguished from other sweet roots when mixed with coffee.

The following represents the per-centage composition of the ash of four samples of chicory, according to Messrs. Graham and Stenhouse:—

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* Chemical Report on the mode of detecting Vegetable Substances mixed with Coffee, Dec. 1852.

	Darkest English Yorkshire.	English.	Foreign.	Guernsey.
Potash	33·48	24·88	29·56	32·07
Soda	8·12	15·10	2·04	3·81
Lime	9·38	9·60	5·00	5·31
Magnesia	5·27	7·22	3·42	3·85
Sesquioxide of iron	3·81	3·13	5·32	3·52
Sulphuric acid	10·29	10·53	5·38	6·01
Chlorine	4·93	4·68	3·23	4·56
Carbonic acid	1·78	2·88	2·80	3·19
Phosphoric acid	10·66	11·27	7·06	6·65
Silica	3·81	2·61	12·75	10·52
Sand	9·32	8·08	23·10	20·19
	100·85	99·98	100·66	99·68

Messrs. Graham and Stenhouse found the silica and sand insoluble in acids to be, in four samples of roasted chicory, as follows,—10·69, 13·13, 30·71, and 35·85 per cent. of the ash; the quantities of this silica soluble in alkali was, in the same samples, 8·08, 9·32, 20·19, and 23·10 parts. Much of this silica was doubtless derived from the sand and dirt adhering to the imperfectly cleansed roots.

The chief constituents of roasted chicory are the gum, glucose, and caramel. The quantity of nitrogen in chicory is not one-half that of coffee.

By an examination of the foregoing analyses it will be seen that the root does not contain anything which can possibly be regarded as a substitute for coffee. It will be also manifest that in the process of roasting, the bitter principle of the recent root is partly destroyed, and that by the torrefaction of the saccharine and other constituents a quantity of caramel is produced, which has no virtue beyond that of burnt sugar. The large quantity of oil found is doubtless derived from the lard used in roasting the root: nearly 5 per cent. of fat has been obtained from some samples of torrefied chicory. The quantity of oil naturally present in the root is exceedingly small. It is likewise evident that the kiln-dried root has undergone fermentation, whereby the amount of sugar has become greatly increased.

Structure of Chicory Root.

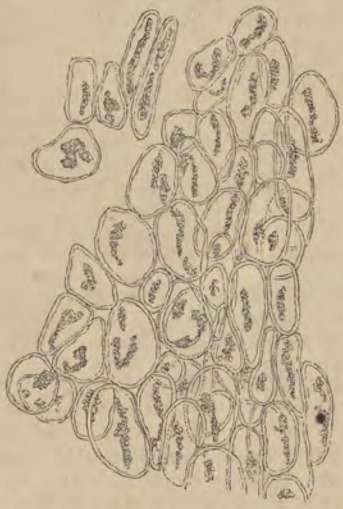
In the raw chicory root four parts or structures may be distinguished with facility: cells, dotted vessels, vessels of the latex, and woody fibre.

When the adulterating grinder or merchant, in the secresy of his own warehouse, first reduced chicory root, parsnips, corn, beans, &c., to charred and nearly impalpable powders, the idea probably never entered his mind that enough of the distinctive structural characters of each of these substances still remained undestroyed, to enable the man of science to drag to light his guilty deeds, and to detect their presence in every parcel of adulterated coffee sent out from his premises.

In the roasted and charred chicory root the same structures may be detected as are distinguishable in the raw or unroasted root.

The chief part of the root is made up of little utricles or *cells*. These are generally of a rounded form, but sometimes they are narrow and elongated. The former occur where the pressure is least and the root soft; the latter in the neighbourhood of the vessels.

Fig. 33.



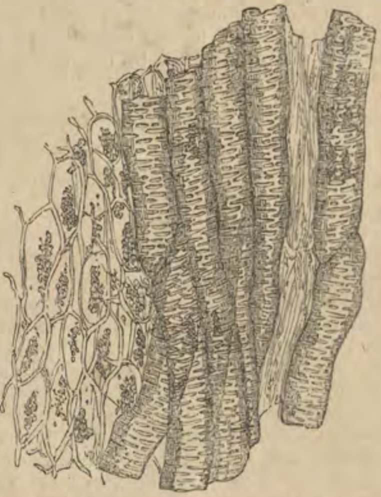
Fragment of ROASTED CHICORY ROOT, taken from a sample of adulterated coffee, showing the cells of which it is principally constituted. Drawn with the Camera Lucida, and magnified 140 diameters.

The *dotted vessels* are particularly abundant in the central and harder parts of the root, which they traverse in bundles: they are cylindrical unbranched tubes, tapering to a point at either extremity, and elegantly marked on the surface with short fibres, describing an interrupted spiral course. *Fig.* 34.

In studying the structure of chicory root, we have clearly made out the origin of the dotted vessels in narrow elongated cells, tapering to a sharp point at either end, at first smooth, but subsequently exhibiting faint oblique markings.

The vessels of the latex, *vasa lacticentia*, are present in most plants, having a milky juice or sap; they form branched and frequently anastomosing tubes, of smaller diameter than the dotted vessels, and with smooth membranous parietes.

Fig. 34.



Fragment of ROASTED CHICORY ROOT, taken from a sample of adulterated coffee, showing the dotted or interrupted spiral vessels, which pass in bundles through the central parts of the root. Drawn with the Camera Lucida, and magnified 140 diameters.

These vessels afford a useful means by which chicory may be distinguished from most other roots employed in the adulteration of coffee.

The *woody* fibre of chicory root does not present any markings or other peculiarities of structure of a distinctive character.

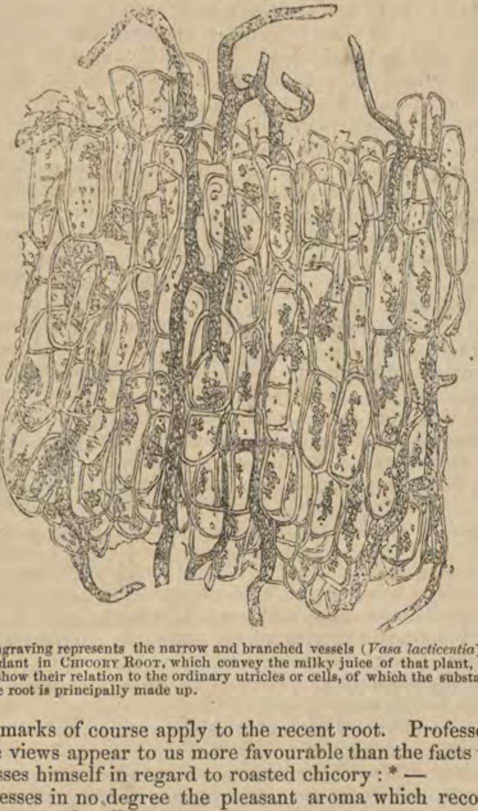
Properties of Chicory.

Recent chicory root is possessed of active medicinal properties, in consequence of which it has long been included in the "Materia Medica."

These properties resemble closely those of the allied plant, the dandelion, in reference to which we find, in the work of Dr. Pereira, the following observations: —

"Its obvious effects are those of a stomachic and tonic. In large doses it acts as a mild aperient. Its diuretic operation is less obvious and constant. In various chronic diseases, its continued use is attended with alterative and resolvent effects; but where the digestive organs are weak, and readily disordered, taraxacum is very apt to occasion dyspepsia, flatulency, pain, and diarrhœa."

Fig. 35.



This engraving represents the narrow and branched vessels (*Vasa lacticentia*), so abundant in Chicory Root, which convey the milky juice of that plant, and also show their relation to the ordinary utricles or cells, of which the substance of the root is principally made up.

These remarks of course apply to the recent root. Professor Johnston, whose views appear to us more favourable than the facts warrant, thus expresses himself in regard to roasted chicory: * —

"It possesses in no degree the pleasant aroma which recommends the genuine roasted coffee.

"The active ingredients in roasted chicory are, first, the empyreumatic volatile oil: this is produced during the roasting; and though not so fragrant, this oil probably exercises upon the system some of the gently exciting, nerve soothing, and hunger staying influence of the similar ingredients contained in tea and coffee; and, second, the bitter principle. When taken unmixed, this substance is to many, while they are unaccustomed to it, not only disagreeable, but nauseous in a high degree. It may, however, like many other bitter principles, possess, as I have said, a tonic or strengthening property. Taken in moderate quantities these ingredients of chicory are probably not injurious to health, but by prolonged and frequent use they produce heartburn, cramp in the stomach, loss of appetite, acidity in the mouth, constipation with intermittent diarrhœa, weakness of the limbs, tremblings, sleeplessness, a drunken cloudiness of the senses, &c. &c. At the best, therefore, chicory is a substitute for coffee to which only those to whom the price is an object ought to have recourse."

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* Loc. cit., p. 215, 216, and 217.

This opinion of Professor Johnston agrees, therefore, nearly with that of M'Culloch, already quoted, to the effect that chicory "has nothing to recommend it except its cheapness."

For ourselves, we would remark that while chicory is substituted to an enormous extent for coffee, it yet possesses none of the characteristics of a true substitute. We believe that the quantity of "empyreumatic essential oil" present is infinitesimal, and that the "bitter principle" consists chiefly of burnt sugar.

Although we are not disposed to attach, therefore, much weight to *these so-called active ingredients* in roasted chicory, it is yet certain that it does contain constituents possessing active and medicinal properties not of a desirable character in an article of food.

Thus, it is very certain that the infusion of roasted chicory is aperient.

In proof of this we will cite the results of some observations of our own.

Three persons partook of chicory at breakfast. The infusion was dark-coloured, thick, destitute of the agreeable and refreshing aroma so characteristic of coffee, and was of a bitter taste.

Each individual experienced, for some time after drinking the infusion, a sensation of heaviness, a feeling of weight at the stomach, and great indisposition to exertion; in two, headache set in; and in the third, the bowels were relaxed.

In second and third trials of the chicory, the same feelings, weight at the stomach, and want of energy, were experienced, but no headache or diarrhœa.

Several other trials were subsequently made, with nearly similar results.

But chicory, it will be said, is seldom taken alone in this country, and when mixed with coffee these effects are not produced.

Two persons partook, for a considerable period, twice a day, of an article denominated coffee, costing one shilling and sixpence a pound, and largely adulterated with chicory: during nearly the whole of this time they both suffered more or less from diarrhœa.

From the result of these trials, therefore, we are warranted in concluding that at least some doubt is attached to the assertion of the "wholesome" properties of chicory root as an article of diet.

So well are mothers in France and Germany acquainted with the aperient properties of chicory, that they frequently give infants and young children a strong infusion of the roasted root as an aperient, preferring it to ordinary medicine on account of its less disagreeable flavour.

Again, it is the opinion of an eminent oculist in Vienna, Professor Beer, that the continual use of chicory seriously affects the nervous system, and gives rise to blindness from amaurosis.

These are serious effects of the use of chicory, and should make those in authority hesitate before they foster the use of this article by giving to its sale an undue and unfair preference.

The greater part of the chicory used is grown in this country, and does not pay any duty; and yet it is allowed to be mixed with coffee to any extent, an article bearing a very high duty.

Of the "nutritive" properties of chicory, of which Sir Charles Wood entertained so high an opinion, we need say but little, feeling assured that the reader will scarcely be disposed to question the accuracy of the assertion, that a mouthful of good wheaten bread contains more nourishment than a cup of infusion of chicory.

Chicory and coffee, then, may be thus contrasted.

They differ from each other in their botanical nature, in chemical composition, and in physiological action and properties.

Coffee is the fruit or seed of a tree, while chicory is the succulent root of a herbaceous plant. Now it is a well-ascertained fact, that of all parts of vegetables, the fruit and seeds usually possess the most active properties: this is no doubt due to the circumstance of their being freely exposed to the influence of light and air—agencies which promote chemical changes in the plant, and so effect the elaboration of those complex organic substances on which the activity of vegetables depends. On the other hand, it must be manifest, that, as the roots are removed from the influence of these powerful agencies, they cannot be so richly endowed with active properties; and, indeed, there are but few roots, which contain either alkaloids or volatile oils—the two classes of constituents which give to coffee its peculiar virtues. The distinction, therefore, between the properties of the seeds and roots of plants is very important, and it is especially so in the case before us.

The infusion of the one is heavy, mawkish, and nearly destitute of aroma; that of the other is light, fragrant, and refreshing.

Coffee contains at least three active principles, or constituents, viz., the volatile oil, the tannin, and the alkaloid caffeine; in chicory there are no analogous constituents.

Coffee exerts on the system marked and highly important physiological effects, of a beneficial character. There is no proof that chicory exerts any one of these effects, while it is very questionable whether the properties which it really does possess are not really hurtful.

Adulterations of Chicory.

What! chicory adulterated? A substance used to adulterate another article, itself adulterated? Impossible! Improbable as the thing appears, it is nevertheless true.

When it is remembered that all the vegetable substances employed in the adulteration of coffee require to be charred or roasted, and that to effect this a suitable apparatus is required, such as but few retail grocers possess, it at once becomes at least probable that these substances are prepared for them by other parties.

This impression acquires increased force when it becomes known that the majority of grocers buy their chicory, not in nibs, but *in powder*, and that this is supplied to them by certain wholesale chicory houses, which charge for it, in general, a less price than for the nibs, or unground root itself, or than genuine chicory powder can be fairly sold at.

The substances which are either substituted for chicory, or mixed with it, are very numerous; several of these we have ourselves detected, while others have been discovered from time to time by different parties. *They include all those employed in the adulteration of coffee;* indeed the greater number of substances met with in adulterated coffee are introduced into it through the chicory with which it is mixed.

This conclusion is deduced not only from the examination of a considerable number of samples of powdered chicory, but from evidence derived from other sources.

Dr. Pereira, in 1845, published in the "Pharmaceutical Journal" two very useful articles on the adulteration of coffee and chicory: from the first of these—that on coffee—we extract the following remarks:—

"But while the grocers, on the one hand, cheat their customers by adulterating coffee with chicory, the chicory dealers in turn cheat the grocers by adulterating chicory;" and he then goes on to describe certain adulterations of chicory, those with *Hambro' powder and coffee flights.*

Another circumstance which proves not only that chicory is adulterated, but also that the sellers of chicory powder are in some cases parties to the adulteration, is that the powder is sometimes sold under the market price at which genuine chicory can be procured.

The substances with which chicory has been ascertained to be adulterated, are all those articles which have been enumerated under coffee; namely, different kinds of roasted corn, as *wheat*, and *rye*, *beans*, *acorns*, *carrots*, *mangold-wurzel*, *beet root*, *sawdust*, *baked livers*, *burnt sugar* or *black jack*, *Venetian red*, and other analogous red earths.

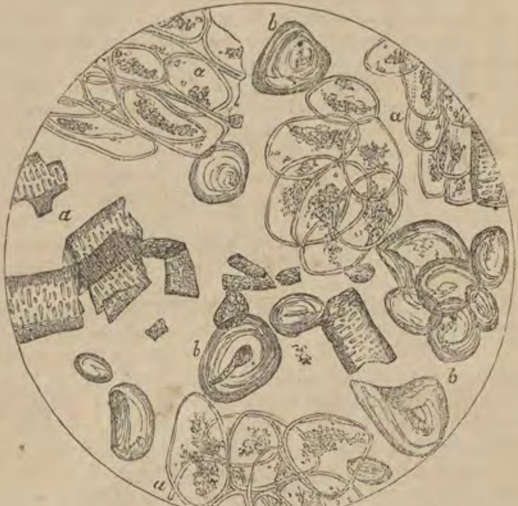
With regard to the use of carrots and parsnips, Mr. Gay, in evidence before the Parliamentary Committee, makes the following statement:—

"I remember, one year when chicory was worth 21*l.* per ton, manufacturing 700 tons of carrots into chicory. They were grown by one gentleman in Surrey, and supplied to the house where I was, and 350 tons of parsnips."

Besides the above named articles, "*coffee flights*" and "*Hambro' powder*" have been used, as also, it has been alleged, *exhausted tan*, known as *croots*, and *oak-bark powder*.

The following engravings exhibit the microscopical characters of chicory adulterated with wheat flour, also with a substance resembling ground acorn, of oak-bark tan powder, and of exhausted tan or croats.

Fig. 36.



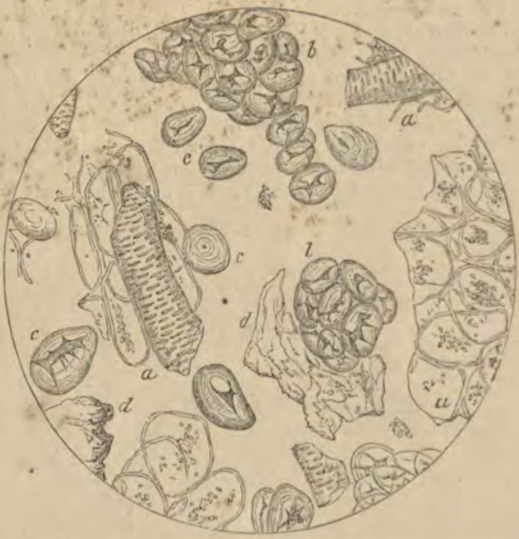
Sample of Chicory, *adulterated with roasted wheat farina*. The structures marked *a a* are the cells and vessels of *chicory root*, while those marked *b b* are the starch corpuscles of *wheat*. No bodies in the least resembling these occur in genuine chicory powder.

According to Dr. Pereira, "*Hambro' powder* consists of roasted and ground peas, &c., coloured with Venetian red. The term *coffee flights* is applied to the thin membranous coat (endocarp) which separates from the coffee seed in the act of roasting."

In Dr. Pereira's article on Chicory we meet with the following remarks in reference to Venetian red:—

"In a previous number we explained the nature of *Venetian red.* It is essentially the sesquioxide of iron, obtained by calcining common copperas (sulphate of iron). The different colours of the product depend on the temperature to which the sesquioxide is subjected. When it has been exposed to an intense white heat, its colour deepens, and it is then termed *purple-brown.* The lighter tint of Venetian red is produced by adulteration. Our informant (a manufacturer) told us that Venetian red was 'adulterated to suit the various prices of the market.' We did not think it expedient to pry into the nature of the adulterating ingredient, but a friend suggests that it is *reddle*, the substance used for marking sheep.

Fig. 37.

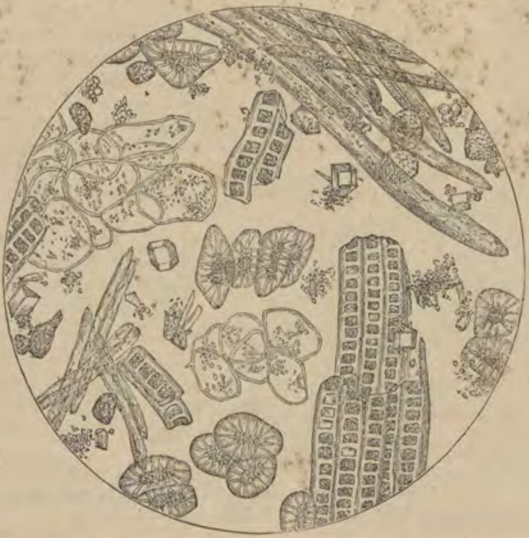


a a, cells of *chicory; b b*, fragments containing numerous starch corpuscles, resembling those of *acorn; c c*, separate starch granules; *d d*, portions of a brown membrane, without apparent organisation, very commonly observed, and derived from the testæ of the seed.

"Venetian red is, we believe, the principal substance at present used for colouring chicory; occasionally other agents have been employed. A dealer tells us that he once bought a quantity of chicory which contained 20 per cent. of *logwood* and *mahogany dust.*"

Results of the Examination of Samples.

Fig. 38.



This drawing exhibits the structures detected in Oak-bark powder,—the *radiate cells, woody fibre,* and *utricles of cellular tissue.* Drawn with the Camera Lucida, and magnified 140 diameters.

The results of the Microscopical examination of *Thirty-four* samples of chicory powder, made some time back, some of which were purchased of different grocers and others obtained from manufacturers, were,—

1st. That *Fourteen* samples were *adulterated.*

2nd. That in *Nine* the adulteration consisted of *roasted Corn.*

3rd. That *scorched Beans* were present in *Four* of the samples.

4th. That in *One* case ground *Acorn* was detected.

The results of the examination of *Twenty-three* other samples made at a subsequent period were,—

1st. That *Eleven or one-half of the samples were adulterated.*

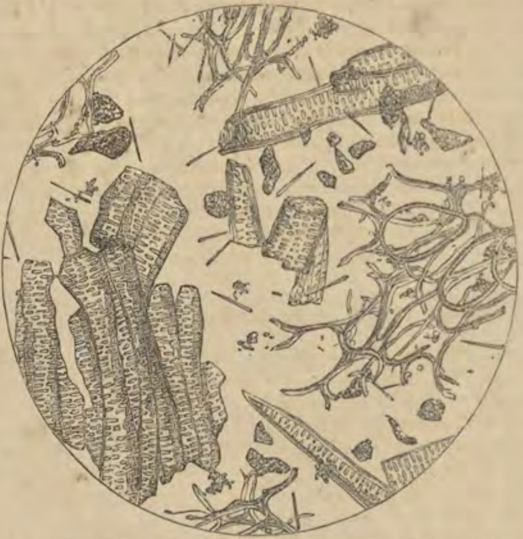
2nd. That *Four of the chicory powders were adulterated with roasted Wheat.*

3rd. That *ground Acorns were present in an equal number of cases.*

4th. That *Two of the samples contained Sawdust, and one Mahogany Sawdust.*

5th. That *Mangold-wurzel was detected in One of the chicories.*
6th. That *in One instance roasted Carrot was present.*

Fig. 39.



This drawing exhibits the structures detected in the TAN known in Norfolk by the name of "*Croats*," and used for fuel, &c.

Lastly, the results of the examination of *Thirty-eight* additional samples of chicory, both as purchased from shops and as procured from manufacturers, and which examination was instituted mainly for the purpose of determining whether Venetian red or other analogous ferruginous earth was employed to colour chicory, were,—

1st. That out of the *Eighteen* samples of chicory procured from manufacturers, *Five* were adulterated with *roasted wheat farina.*

2nd. That *several* of the samples yielded a *coloured ash.*

3rd. That out of the *Sixteen* samples of chicory purchased at the establishments of different grocers in the metropolis, *One* was adulterated with *roasted farina.*

4th. That the *ashes* of several of the samples were *highly coloured,* indicating the presence of some *red ferruginous earth,* as *reddle or Venetian red.* In two samples the incorporation was so imperfect that we were enabled to separate large particles of the Venetian red from the chicory powder.

We have now shown,

That chicory, an article used to adulterate another article, is itself largely adulterated.

That the dealers in or manufacturers of chicory are in many cases the parties who practise this adulteration.

We are sorry, however, to declare, that in those instances in which the retail grocers do not themselves adulterate the chicory they vend, we are unable to acquit them of guilty knowledge of and participation in the fraud: this knowledge is displayed in the fact that the fraudulent grocer frequently purchases chicory in powder, at a price at which it is not possible to procure genuine chicory.

The prices demanded for the several samples analysed varied from 5*d.* to 1*s.* per lb.; the ordinary charge being 8*d.* The price of chicory in powder to the trade ranges in general from 20*s.* to 32*s.* per cwt.; thus the profit of the retail grocer on the sale of chicory powder is seldom under cent. per cent., and often much above it.

On the Detection of the Adulterations of Chicory.

The Chancellor of the Exchequer, in May (1850), stated to the House of Commons, that "having desired the Board of Inland Revenue to state whether there was any ready and available proof of the mixture of chicory with coffee, he had received a reply to the effect, that four experienced persons having been employed in making experiments, the result of the inquiry was, that neither by chemical tests, nor in any other way, could they ascertain, with any degree of certainty, whether the mixture contained chicory or not." *

Notwithstanding this formal and apparently authoritative statement, the fact is that few things are easier of detection than the presence of chicory in coffee by means of the microscope: the detection of the adulterations of chicory itself are for the most part not more difficult.

The identification of chicory with certainty, either in the pure state, or when mixed with other articles, by other means than the microscope, is by no means easy, if it be not impossible, in the present state of science.

It has been repeatedly stated that coffee and chicory may be distinguished by the manner in which they comport themselves when placed on the surface of water; the chicory powder, it is said, soon sinks, while coffee floats. In the case of the majority of samples of chicory examined this test completely failed, as the powder did not sink, but rested on the surface for a considerable time, and continued perfectly dry,— a result possibly attributable to the presence of the lard used in the roasting of the nibs.

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* On being reminded of this Report by Mr. Scholefield, Mr. George Phillips makes this notable reply: — "Yes, that is as far back as 1849. The fact is, the subject had not then been studied as regards the adulteration of coffee and chicory."

So that until recently, on the admission thus publicly avowed by the chief scientific authority connected with the Excise, the grocers, for anything the Excise could do, might adulterate their coffee and chicory as much as they pleased! Pretty protection of the revenue truly!

Another way recommended to detect an admixture of chicory with coffee, is to add some of the suspected powder to cold water. If chicory be present, the water will quickly become coloured, and by the depth of the colour the proportion of chicory may be guessed at. This method is, however, utterly fallacious, since the colour may arise from the presence of burnt sugar, so commonly used, or of roasted wheat, carrot, and other similar substances.

The adulteration with chicory has been attempted to be established by having regard to the relative specific gravities of infusions made from equal quantities of coffee and chicory. It has been found that the infusion of coffee is of much lighter specific gravity than one of chicory, the difference in fact being about 1 to 3; but since other sweet roots, as well as maize, rye, &c., yield infusions equally heavy with that of chicory, this test is useless as a means of determining the fact of the adulteration of coffee with chicory. The colour of the infusion and its specific gravity, doubtless afford rough and general indications as to whether any particular samples of coffee are genuine or not, but it is impossible by these characters to pronounce an opinion as to the nature of the adulteration practised.

The difficulty of detecting chicory by chemical means arises from the absence of any peculiar and distinctive principles in the roasted root. Various attempts have been made with the view to discover some characteristic reactions and peculiarities of composition; Messrs. Graham, Stenhouse, and Campbell especially have directed their attention to this subject.

These chemists have, amongst other points, endeavoured to make use of the colour and specific gravity of the different infusions used as a means of detecting the adulterations of coffee with chicory and other roots; but these data are not capable of affording any precise or reliable conclusion.

They have also endeavoured to avail themselves of the presence of *glucose* or *grape sugar* in chicory as a means of discrimination; thus, while the sugar in roasted coffee rarely exceeds 1 per cent., and is usually only half this quantity, in roasted chicory it has been found to range from 11·98 to 9·86 per cent.; but since other sweet roots, as beet root, mangold-wurzel, turnips, dandelion, carrots, and parsnips, contain on the average as much sugar as chicory, this means utterly fails as a test for chicory. The utmost that can justly be inferred from the presence of a considerable amount of sugar in ground coffee is, that it is adulterated, and *probably* with one or other of the roots above-named. Further. the presence of sugar in small quantity affords no proof of the genuineness of coffee, since some of the cereals and other substances employed to adulterate coffee are equally deficient with it in saccharine matter. Lastly, sugar is often purposely added to coffee, sometimes during the roasting, and subsequently in the form of burnt sugar or black jack.

Again, they have availed themselves of the quantity of *silica* present in the ashes of coffee and other vegetable adulterants as another means of discrimination. The silica of roasted coffee averages usually about a quarter and rarely approaches one half per cent.; while, as has been already shown, the sand and silica, insoluble in acids, of four samples of roasted chicory amounted to as much as 10·69, 13·13, 30·71, and 35·85 per cent. of the ash: but in roasted dandelion root the proportion of silica is as great as in chicory, great part of the silica in both cases being derived from the dirt still adhering to the imperfectly cleansed roots. The same is the case with the roots of carrots and parsnips prepared in the same rough way for use as chicory root, The presence, therefore, of a large excess of silica does not prove the fact of adulteration with chicory; indeed, it can scarcely be said to afford decisive proof of adulteration of any kind, since any excess of silica might be due simply to the fact of a little sand becoming accidentally mixed up with the coffee. In the cereals again, with the exception of maize, the ash of which contains about 2 per cent., the silica is high, as shown by the researches of Messrs. Ogston and Way, who state that in wheat the silica varies from 20·5 to 54·6 per cent.; in barley from 23·6 to 70·77; in oats from 38·48 to 50·03; while in rye it is about 9·22.

Lastly, Messrs. Graham and Stenhouse have examined the *ash* of coffee and chicory, and certain other adulterants, with a view to discover distinctive characters. The principal differences in the composition of the ash are shown by the figures given below: —

	In Coffee Ash.	In Chicory Ash.
Silica and sand	-	10·69 to 35·85
Carbonic acid	14·92	1·78 to 3·19
Sesquioxide of iron	0·44 to 0·98	3·13 to 5 32
Chlorine	0·26 to 1·11	3·28 to 4·93

Extending the comparison further, however, we find in a variety of other vegetable substances, even of those used in the adulteration of chicory and coffee, an excess over the quantities usually contained in coffee of all the constituents referred to above. Some of the substances in which excess of *silica* occurs, have already been mentioned. *Carbonic acid* occurs in nearly the same proportion in acorns, parsnip, beet root, carrot, and turnip, as in coffee; the quantity of chlorine approximates to chicory in acorns, parsnip, carrot, turnip, and dandelion roots; lastly, the *iron* is excessive in dandelion and beet root, and would be so no doubt in carrot and parsnip roots imperfectly cleansed and freed from dirt. Besides, all conclusions based upon an excess of iron, except the general one that adulteration with some substance containing an excess of that metal has been practised, are precluded by the fact that chicory and other roots employed to sophisticate coffee are themselves often adulterated with red ferruginous earths, as Venetian red and reddle, containing, frequently, excess of carbonic acid, lime, iron, and silica.

The ash of coffee adulterated with any of the cereals, and also to a less extent with lupins, peas, and beans, is, of course, distinguished by the large amount of phosphoric acid present. In coffee the phosphoric acid may be set down at about 10 per cent.; in chicory it varies from 6·85 to 11·27; in lupins it is usually about 25 per cent., and in maize 44 per cent.

With regard to the nitrogen of coffee and chicory, the authors of the Report under consideration remark:—"The proportion of nitrogen in coffee is, therefore, greater than in chicory; but the difference is not sufficiently marked to distinguish the two substances readily from each other. The conclusion may, however, be drawn that less than 2 per cent. of nitrogen in coffee is a strong presumption of adulteration."

It is obviously best, therefore, not *to waste time* in the prosecution of chemical methods of research leading to no certain results, but at once to have recourse to the microscope; by this instrument all the adulterations of coffee and chicory with vegetable substances are discoverable with ease and certainty. In the case of chicory, it is only necessary to ascertain by it whether those structures characteristic of its root (see *figs.* 33, 34, and 35.) are present or not, to observe well the size of the cells, whether they contain starch or not, the size and character of the vessels, and especially whether *vasa lacticentia* are present.

For this purpose, a grain or so of the powder should be placed on a slip of glass, a drop or two of water added, and the larger particles, which swell up and become more visible than when in the dry state, torn into pieces by means of needles. A little of the powder should then be placed on a clean slide, covered with a piece of thin glass, and subjected to examination with the ½-or ¼-inch object-glasses.

The adulterations of chicory being for the most part the same as those of coffee, similar means must be had recourse to for their detection: when these consist of vegetable substances of any kind, the microscope will be found to supply the only ready and certain means of detection; when of chemical substances, as burnt sugar or Venetian red, chemical methods of research must be resorted to. For a detailed description of the characters of the various substances used in the adulteration of coffee and chicory, and of the means for their discovery, the reader is referred to the preceding article on Coffee.

The detection of substances containing starch by *chemical means* is attended with even greater difficulties than in the case of coffee, the blue colour developed on the addition of iodine being obscured by the deep brown colour of the infusion of chicory.

It may be thus effected, however: iodine may be applied to a small quantity of the article placed under the microscope, but in order to determine the quantity present we must proceed as follows:—A carefully prepared infusion of the article is to be made: this is to be divided into two parts; in one, the sugar is to be determined by Fehling's solution, or by converting it into alcohol; the other is to be boiled with dilute sulphuric acid until all the starch is changed into grape sugar, from the amount of which present (deducting, of course, the glucose not derived from the conversion of the starch) the starch itself may be calculated.

The evidence of the use of *Reddle and Venetian red* is principally derived from the incineration of a certain quantity of the suspected chicory powder, and by analysis of the ash. All vegetable substances, whether coloured or not, yield, on incineration, a greyish-white ash. The ash of coloured earthy substances, on the contrary, after being burned in a crucible, remains more or less coloured.

As, however, chicory is the root of a plant, and as the earthy matter is but seldom entirely removed from it by washing, the ash of even genuine chicory not unfrequently exhibits, on this account, a slight degree of colouration, being occasionally brownish, or of light-fawn colour. It is only, therefore, when the ash is decidedly coloured, and especially when of a red or rusty-red colour, that the presence of Venetian red, reddle, or some other analogous substance, is rendered certain.

In these facts, therefore, we have a ready means of determining whether a sample of chicory, or any other vegetable powder, contains an admixture of any mineral colouring matter containing iron, a conclusion which may be further confirmed by chemical analysis.

On the Quantitative Estimation of Sesquioxide of Iron in Chicory.

Although the presence of iron is sufficiently indicated by the colour of the ash of chicory, and most other vegetable substances, yet in some cases it becomes necessary to determine its amount.

For this purpose, the ash (say of 500 grains of chicory) should be boiled with dilute hydrochloric acid until all the iron has become dissolved, the acid evaporated nearly to dryness, about an ounce of distilled water added, the solution filtered, and the iron precipitated as sesquioxide by means of solution of ammonia, the precipitate collected, washed with hot water, ignited, and weighed.

This process is applicable only, however, in the absence of earthy phosphates or alumina, as these are also precipitated by ammonia.

The alkaline earths may be dissolved out of the ammonia precipitate by means of an exceedingly dilute solution of hydrochloric acid. This will not affect materially either the iron or the alumina. By a solution of nitric acid, 1 part to 30 or 40 of water, the iron also, if in small quantity, may be separated from the alumina.

By the following process the sesquioxide of iron may be separated from the alkaline earths, alumina, lime, and magnesia:—

The ignited and weighed residue is to be dissolved by digestion with concentrated hydrochloric acid, or by fusion with bisulphate of potassa.

Boil the solution first with some sulphate of soda, and then with solution of soda, which will take up the alumina. Wash the residue thoroughly, dissolve it in hydrochloric acid, precipitate the sesquioxide of iron, observing the necessary precautions, with succinate of ammonia.

Or the iron may be precipitated by sulphide of ammonium.

Mix with the acid solution ammonia, until a precipitate just begins to form, then with sulphide of ammonium; separate the precipitate which contains iron, also manganese, should that metal be present, by filtration; dissolve it in hydrochloric acid, and separate the iron from the manganese, if any, by succinate of ammonia. If there is no reason to suspect the presence of manganese the precipitation with succinate of ammonia may be omitted. The alumina and the earthy phosphates are in the filtrate; but if too much ammonia is added, they too would in part be thrown down.

The succinate of ammonia is used in the following manner:—A very dilute solution of ammonia is added drop by drop to the solution containing the iron, until a small portion of the metal precipitates in the form of hydrated sesquioxide: a gentle heat is then applied to ascertain whether the precipitate will redissolve or not; if it does so, more ammonia is added, until the application of heat fails to dissolve the precipitate formed. If, on the contrary, it remains undissolved, and the fluid continues to be of a brownish-red colour, all the conditions requisite are fulfilled. But should the fluid be colourless, too much ammonia has been added, in which case a small quantity of hydrochloric acid must be added, and then, again, more ammonia, until the point desired is obtained. A perfectly neutral solution of succinate of ammonia is now to be added so long as any precipitate falls; a gentle heat is then applied, the fluid is afterwards allowed to cool, and when cold it is filtered, the precipitate washed on a filter, first with cold water, and afterwards with hot solution of ammonia; it is then dried and ignited thoroughly until it is all converted into sesquioxide.

The cases, then, of coffee and chicory afford striking illustrations of what can be effected in the discovery of adulteration by means of the microscope.

The article on Chicory may be concluded by a review of reasons urged both for and against the admixture of chicory with coffee taken from the author's book entitled "Food and its Adulterations." Some of the remarks contained in this review, require to be modified to some extent in consequence of the alteration which has taken place in the law since the review was drawn up, by which it is required that chicory should not be sold mixed with coffee, except the fact of such mixture is specified by a label. This law is, however, constantly evaded: the mixture is sometimes sold without the label; in other cases it is palmed off where coffee only is asked for; and lastly, in some instances the so-called mixture consists almost entirely of chicory.

Review of Reasons urged both For and Against the Admixture of Chicory with Coffee.

Various reasons have been urged both in favour of and against the "adulteration," or, as the Chancellor more gently phrases it, the "mixing" of chicory with coffee: these we will next proceed to consider.

In *favour of the adulteration* it is alleged,—

First, that the *admixture of chicory with coffee improves coffee*, and that *such addition is approved by the public.*

In order to ascertain whether the addition of chicory to coffee be really an improvement, we prepared three infusions, one of coffee, another of chicory, and the third of both these mixed in the proportion of three-fourths coffee and one-fourth chicory.

The *infusion of coffee* was perfectly transparent, and of a dark and rich brown colour; it emitted an odour in a high degree penetrating and refreshing, and to the taste it was agreeable, and rather bitter.

Having been taken for a few minutes, it produced a feeling of general warmth, and a state of bodily and mental activity and invigoration.

The *infusion of chicory* was opaque, staining the sides of the vessel containing it; it possessed a heavy, though perhaps some persons might be of opinion not a disagreeable smell, wholly unlike, however, the volatile and diffusive odour of coffee; in taste it was more bitter than the coffee infusion, with a certain degree of sweetness.

Having been swallowed for a few minutes, it occasioned a feeling of weight at the stomach, and a general heaviness and indisposition to bodily and mental exertion.

The combined infusion of chicory and coffee partook, to some extent, of the characters of the infusion of genuine coffee, as might be anticipated from the coffee it contained.

Altogether, we were unable to bring ourselves to believe that the addition of chicory to coffee in the proportion of twenty-five per cent. of the former was any improvement; on the contrary, we were satisfied that the quality of the beverage was greatly impaired by the addition.

Persons who are foolish enough to regard a slight sensation of weight and fulness in the region of the stomach—symptoms really of incipient indigestion—as evidences of the beverage being possessed of increased "strength" and "body," and whose nasal organs are insensible to the delightful aroma of coffee, might possibly be brought to consider the addition an improvement.

In contrasting the properties of chicory and coffee, we would once more observe it must not be forgotten that the former article is wholly destitute of that peculiar principle "*caffeine*," upon which the virtues of coffee in part depend, and that therefore for every ounce of chicory in a pound of coffee there is so much the less of that stimulating and invigorating nitrogenised product.

Allowing, however, for the sake of argument, that the admixture of chicory in moderate proportions is in the opinion of some persons an improvement, it is very certain that by others it is not considered to be so; and such, therefore, ought surely *to be allowed a choice*, and not be compelled, as they frequently are, to drink chicory although they dislike it.

But the admixture of chicory with coffee in the proportion of twenty-five per cent., the utmost that can be allowed by any person to constitute an improvement, does not in general satisfy the desire for profit on the part of the grocer; he uses, in most cases, a very much larger proportion of chicory than this, and the shilling coffee, "*the poor man's beverage*," contains one-half or three-fourths chicory, and in some instances consists entirely of it. Now no truthful person will assert that chicory in these, the more common proportions, is an improvement to coffee.

Second, that *the use of chicory increases the consumption of coffee.*

This statement, although recently put forth by no less an authority than a late Chancellor of the Exchequer, is just the very reverse of the truth, which is, that the use of chicory diminishes the consumption of coffee. This we have already clearly proved, and it is not necessary that we discuss this point again. It is settled.

Third, that *the poor man, by the employment of chicory, has an article placed within his reach which otherwise he could not obtain.*

This argument, although specious, is utterly fallacious.

Genuine coffee, ground, or in the berry, may now be obtained at numerous respectable establishments, at 1*s.* 2*d.* and 1*s.* 4*d.* per pound, this article costing the grocer more than three-fourths of the sum he demands for it.

The mixture of chicory is never sold under 1*s.* per lb., and the cost of chicory to the grocer very frequently does not exceed 3*d.* a pound.

Which of these two articles, therefore, we ask, is the *best poor man's bargain?*

Shilling coffee, as vended at the present, is vile and often deleterious rubbish, and we recommend the poor man never to purchase it.

We say, therefore, so far from the poor man being benefited by the use of chicory, that out of every shilling he spends in what is falsely denominated coffee, he is frequently robbed of 9*d.*

We can well understand how the poor man or the poor man's wife, having, on a Saturday night, only a few shillings to spend, and desiring to make these go as far as possible, is induced to purchase the cheapest articles he or she can procure, overlooking the fact, that, although professedly the cheapest, they are often in reality the dearest in the end.

We wish the poor man, therefore, clearly to understand, that chicory is not to be compared to coffee in any respect, and we would have him avoid the "cheap and cutting shops," distinguished by large placards and huge piles of damaged goods, and buy his coffee at some house of known and acknowledged reputation and respectability.

Apprehensive that Government will be forced to take notice of the scandalous practices now so rife in the article coffee, the adulterating grocers have already begun to raise the cry of "dear coffee," and they tell us, that if the admixture of chicory with coffee be prohibited, the price of the latter article will be 2*s.* the pound.

The answer to this statement is, that excellent *genuine coffee* may now be obtained, at establishments which do not use chicory in their business at all, at prices varying from 1*s.* 2*d.* to 1*s.* 6*d.* per pound.

Fourth, that *the law sanctions the adulteration of coffee with chicory*, and therefore that the grocer, in mixing these articles, is guilty of no fraud.

As the law at present stands, it must be conceded, we are sorry to say, that in mixing chicory with coffee the grocer does not violate the law, but only does that which the executive and its officers, to their shame be it said, not alone sanction, but actually recommend.

We hold, however, that in vending an article as coffee which is not coffee, the grocer is guilty of a moral fraud, and that which is morally wrong no act of parliament and no ministers can make morally right.

Fifth, and lastly, it is alleged that there is no necessity for legislative interference, since, *by buying the coffee berries in the whole state, the public can protect itself.*

Those who use this argument cannot but be aware how inefficient, practically, is the protection here referred to.

The poor man has not the money wherewith to purchase a mill; and if he had, working early and late, rising at six in the morning, and going to bed late at night, what time or spirit has he to attend to such matters?

Again: others not so poor, and who are in a position to make the necessary purchase, are perhaps equally engaged, or ignorant of the extent to which they are cheated.

Even of those who have both money and leisure we affirm that not one in twenty avails himself of the protection which the purchase of the whole berry affords; nor, since he pays a fair price for an article which he specifies, ought he to be called upon to adopt measures of extraordinary precaution against fraud.

We are not disposed, however, to underrate the value of this means of protection, and we have pleasure in stating that efficient coffee mills may be procured at a trifling cost.

We put it to coffee merchants and respectable dealers whether it be not advisable that they should themselves take some steps to supply the public with cheap and effective coffee mills.

We have now to consider the chief arguments which have been or may be advanced against the adulteration of coffee with chicory.

Against this practice we allege,

First: that such adulteration *necessitates the commission of a moral fraud*, and further, that it is frequently made the cloak for pecuniary fraud and extortion.

When a purchaser enters a shop, asks for an article, pays the price demanded for it, he has a right to expect that he shall obtain that for which he asks, and not a mixture of two different things, one of which he probably positively objects to, and the relative proportions of which are regulated by the will and conscience of the vendor. The grocer who, under such circumstances, places in the hands of the purchaser an adulterated commodity, commits a moral, and frequently a pecuniary fraud.

We will suppose the following case of poisoning, not an improbable or unfrequent one: — An infant has been given an overdose of Godfrey's cordial; the proper remedy is a strong infusion of coffee — the coffee already in the house, inasmuch as it is the most quickly obtained, is used; it consists principally or perhaps entirely of chicory. *The child dies.* Who is the party morally responsible in this case?

Second: that *it is unjust to the grower* of coffee.

The grower of coffee has at least a right to demand, in consideration of the heavy tax which he pays for the privilege of being permitted to import his coffee into England for disposal, that the sale of the article, and its estimation with the public, be not injured by the practice of adulteration, carried on under the sanction, and with the connivance, of the legislature, and even under the very name of coffee.

The payers of duty on other excisable articles are protected against adulteration by law, and the coffee grower has a full right to demand, in common honesty, the same amount of protection.

Third: that *the revenue is injured.*

Whatever lessens the consumption of an excisable article, of course injures the revenue. It has been proved that the mixing of chicory with coffee lessens the consumption of coffee, and therefore, by so much is the revenue diminished and injured.

If the loss in revenue were so much gain to the public, there would be less reason to complain, but this is not the case; the advantage is pocketed by unprincipled grocers.

Fourth: that *the public is defrauded.*

That the public, and especially that large section of it, the poor, is extensively defrauded by the adulteration of coffee with chicory, to say nothing of roasted corn, beans, dog biscuits, &c., has already been clearly proved. Let those who entertain any doubts upon the subject consult the Table of Analyses which we gave in our Report on Coffee.

We have now clearly shown that the disadvantages and evils resulting from the mixture of chicory with coffee, in the manner and to the extent now practised, are great and manifold, and that they demand the application of a suitable remedy.

The remedy which we propose is simple, moderate, and just: it is, that the "Treasury minute," authorising the mixture of chicory with coffee, be rescinded. The effect of this would be, to place coffee upon the same footing with all other excisable articles, as tea, pepper, &c., and that penalties would attach to its adulteration.

Chicory would of course still be sold; but in place of being so clandestinely, it would be vended openly, and under its proper name, and at its fair value.

Public morality, the interests of the revenue, of the grower, the consumer of coffee, and of the honest tradesman alike require the adoption of the remedy here pointed out.

The law, as we are all aware, sanctions the adulteration of coffee with chicory, to the injury of the revenue, and the loss of the public in health and pocket. This same law, however, does not permit the adulteration of coffee with scorched wheat, beans, carrots, &c., but subjects parties practising these deceptions to prosecution, and, in case of conviction, heavy penalties. Such, at least, is the law, but under the present government it is useless law, since, notwithstanding the prevalence of these adulterations, it is rarely enforced.

But, singular to say, the law, while it provides in word against certain of the adulterations to which coffee is liable, is silent with respect to the adulteration of chicory; so that that which is an offence in the case of coffee, is not illegal in that of chicory, with which the manufacturers may mix corn, beans, carrots, mangold-wurzel, mahogany sawdust, &c.: this, to say the least, is grossly inconsistent.

Raw or kiln-dried chicory is free of duty. Roasted or ground 5*d.* per pound at present, but from 5th April 1857, 4*d.* per pound.

The quantities imported can only be learned by an application to the Board of Trade.

COCOA, AND ITS ADULTERATIONS.

Cocoa is prepared from the seeds of *Theobroma Cacao*, so named by Linnæus from the Greek word θεὸς, God, and βρῶμα, food, signifying that cocoa was a food fit for the gods.

It is a small but handsome tree, indigenous to the West Indies and Central America. "It grows spontaneously in Mexico and on the coast of Caraccas, and forms whole forests in Demarara. It is cultivated also in the Mauritius and in the French island of Bourbon."—*Johnston.*

The seeds or beans are enclosed in a pod or fruit somewhat like that of a cucumber, being usually about five inches long, and three and a half in diameter. Each fruit contains in general from twenty to thirty beans, disposed in five rows, which are divided from each other by partitions. Occupying the divisions of the fruit and surrounding the seeds is a rose-coloured spongy substance, resembling that of water-melons.

The above description applies to fruits of average size: sometimes the fruits are so large, especially those grown in Central America, that they contain as many as from forty to fifty seeds; while others, as those grown in the West Indian Islands, Berbice, and Demerara, are much smaller, and enclose only from six to fifteen seeds.

During maturation the fruits change from green to dark yellow; they are then plucked, opened, the seeds cleared of the spongy substance, and spread out to dry in the air.

In the West Indies, immediately that they are dried, the beans are packed up and are ready for the market; but in the Caraccas they are subjected to slight fermentation: for this purpose they are either put into chests or tubs, which are covered over with boards, the beans being turned over every morning to equalise the fermentation, or else they are put into pits or trenches dug in the earth. Lastly, they are exposed to the sun and dried.

During the process the beans emit a good deal of moisture, lose weight, as well as part of their bitterness and acrimony.

The seeds which have undergone the process of fermentation are considered the best; they are larger, of a darker brown colour, and after roasting, throw off their husks readily, and split easily into several pieces or lobes. They have an agreeable mildly bitter taste, without acrimony.

The beans of Guiana and West India cocoa, while they are smaller, flatter, smoother, and of a lighter colour, are also more sharp and bitter to the taste. " They answer best for the extraction of the butter of cacao, but afford a less aromatic and agreeable chocolate." —*Ure.*

Johnston states that the bitterness and acrimony of taste " is greater in the beans of the mainland than in those of the American Islands. The cocoa of Central America is however of superior quality, or at least is more generally esteemed in the European markets than that which is grown in the West Indies. It still retains a greater degree of bitterness, and this may be one reason for the preference given to it.

" The cocoa of Trinidad is the variety chiefly consumed in this country. The quality of the mainland cocoas which come to the English market from Bahia and Guayaquil, for example, has hitherto been always inferior."

The reason of this is, that until recently the duty on foreign cocoa was greater than that on colonial cocoa, being in the one case 2*d.* per pound, and in the other 1*d.* and 5 per cent. This had the effect of excluding all the foreign cocoas of better quality and higher price, which found their way to Morocco, France, Spain, and Italy. Now that the duty is equalised, it may be expected that the finer kinds of foreign cocoa will find their way into the English market.

Previous to being used, the beans are roasted in an apparatus similar to that of a coffee roaster. When the aroma is well developed the roasting is known to be finished. The beans are turned out, cooled, and freed by fanning and sifting from their husks.

Cocoa has been in use in Mexico from time immemorial. It was introduced into Europe by the Spaniards in 1520, and by them it was long kept a secret from the rest of the world.

Composition of Cocoa.

The following is the composition, according to Lampedius, of 100 parts of the seeds of West Indian cocoa deprived of husk:—

Fatty matter	53·10
Albuminous brown matter, containing the aroma of the bean	16·70
Starch	10·91
Gum	7·75
Lignine	0·90
Red pigment	2·01
Water	5·20
Loss	3·43
	100·00 parts.

This analysis entirely overlooks some of the more important constituents of cocoa, as *the volatile aromatic oil*, *the theobromine* analogous to the theine of tea, and the *bitter and astringent principle*. The proportion of *starch* appears also to be somewhat underrated.

The average composition of the entire bean when deprived of its husk, is, according to Johnston, nearly as follows:—

Water	5
Starch, gum, &c.	22
Gluten, &c.	20
Oil (cocoa butter)	51
Theobromine	2
	100[*]

Cocoa, then, contains a great variety of important nutritive principles; as, in addition to the volatile oil, the theobromine, and the bitter principle, gum, starch, much fat and gluten: like milk, it contains every ingredient necessary to the growth and sustenance of the body.

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[*] Other analyses of cocoa are given by M. Payen in his work entitled "Des Substances Alimentaires."

The *volatile oil* is developed during the process of roasting: it is to it that the aroma is due, and which is so powerful, when the cocoa is first roasted. Its action on the system is probably similar to the corresponding oils of tea and coffee, although less considerable, since the quantity of this oil in cocoa is but small.

Theobromine, like theine, is a white crystallisable substance, but differs from it in containing a much larger proportion of nitrogen. The proportion of this substance is usually about the same as in tea, namely 2 per cent. It exists also in smaller quantity in the husk of the bean.

The *bitter and astringent principles* are probably distinct: the bitterness is greater than that of coffee, but the astringency less than in either tea or coffee.

The *concrete fat or oil* is the predominant ingredient in cocoa, forming over one half the weight. In its presence cocoa differs remarkably from tea and coffee.

This fatty oil, termed butter of cocoa, is of the consistence of tallow, melting only at 122° Fahr. It is white, of a mild and agreeable flavour, and is not apt to turn rancid. It is soluble in boiling alcohol, from which it is precipitated as the spirit becomes cold. To obtain it in quantity, the beans, after having been steamed and soaked in boiling water for some time, are subjected to strong pressure in canvas bags. The proportion of butter procured by this method is from five to six ounces to a pound of cocoa, some of the oil remaining behind in the beans. It possesses a reddish tinge when first expressed, but it becomes white by boiling with water.

Cocoa likewise differs remarkably from tea and cocoa in containing a considerable amount of *starch*, an important constituent in nearly all the more valuable vegetable articles of food.

Lastly, it contains a very large amount of *gluten*, usually about 20 per cent.

The *shells* or *husks*, which form about 12 per cent. of the weight of the seeds, contain a little theobromine, a very small quantity of fat, some mucilage, no starch, and much vegetable tissue or lignine.

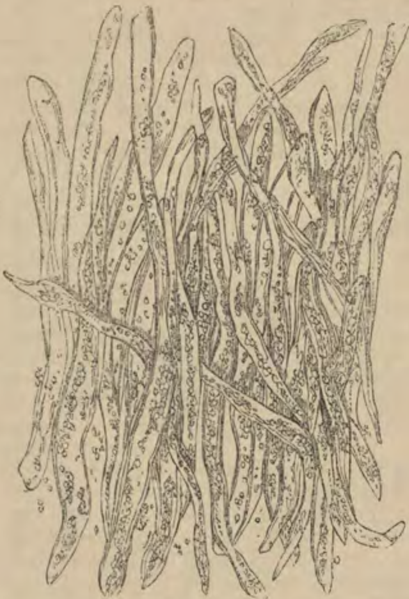
Structure of the Cocoa Seed.

It is of very great importance that the minute structure of all vegetable substances employed in food and medicine should be thoroughly understood; for without such knowledge it is quite impossible to detect the adulterations to which the majority of them are liable.

The structure of the seed, or bean, as it is sometimes called, of the cocoa, is very characteristic, although somewhat complicated: in it, as in other seeds, two parts require to be distinguished, the shell or husk, and the seed proper.

The first structure noticed on the surface of the husk, consists of a considerable number of *tubular fibres* of large size, and containing granular matter and minute corpuscles; they are more abundant on some seeds than others; they do not appear to form part of the seeds, but belong rather to the seed-vessel, and they are probably derived from the spongy substance which surrounds the seeds: the fibres for the most part run parallel to each other in the course of the long axis of the seed.

Fig. 40.



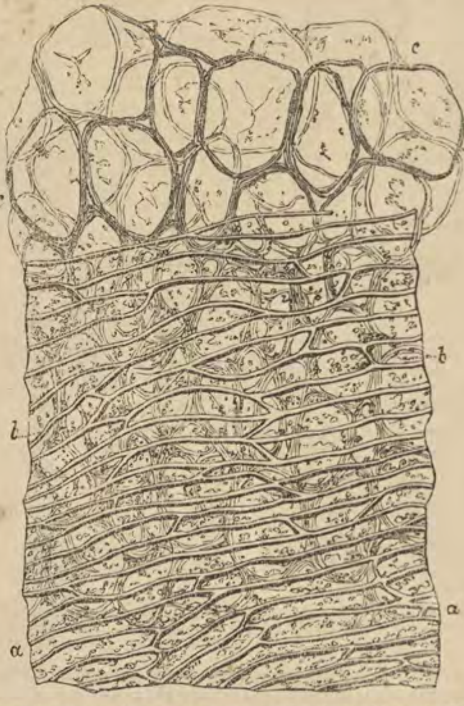
This engraving represents the *tubular fibres* usually observed in greater or less numbers on the surface of the COCOA SEED. The fibres are magnified 100 diameters.

The *husk* may be separated into three or four distinct tunics or membranes.

The *first or outer membrane* consists of elongated cells, adapted to each other, and disposed in a single layer, with their long diameters placed transversely to the axis of the seed.

The *second tunic* is constituted of large angular cells, superimposed in several closely connected layers; towards the centre of the membrane formed by them the cells increase greatly in size, their parietes become thin and diaphanous, and their cavities filled with a mucilaginous substance, which, in the bean soaked in water for some hours, is seen to be considerable in quantity.

Fig. 41.



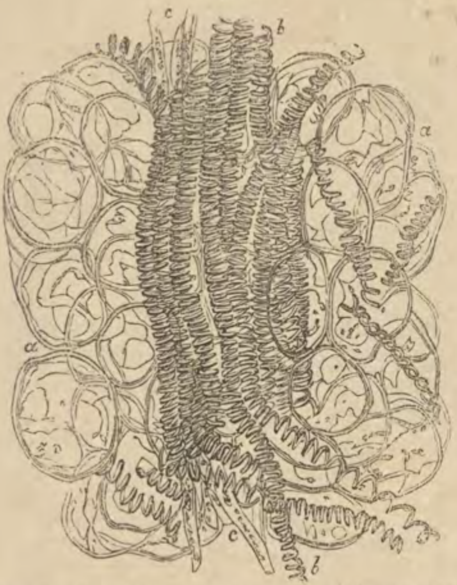
This engraving represents the *two outer tunics of the husks of the seed of* Cocoa, *together with the enlarged and mucilage-bearing cells.* *a*, outer membrane ; *b*, second tunic ; c, mucilage cells. This figure, as well as the three following, are magnified 220 diameters.

These two membranes, together with the enlarged cells, are delineated in *fig*. 41.

As the cells forming the second membrane approach the surface of the seed, they lose their mucilaginous character, become smaller, and return to their original size.

If now the surface of an entire seed enclosed in its membrane be examined, several raised lines or fibres will be observed, commencing at the end of the seed attached to the seed-vessel, spreading them-

Fig. 42.



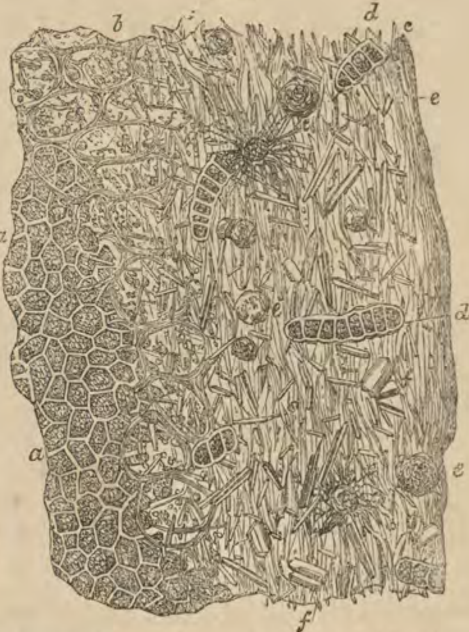
In this figure the *cells, woody fibres*, and *spiral vessels*, are delineated, which constitute the deep portion of the second membrane.

selves out over its surface, and terminating at the distal extremity of the seed: these fibres are composed of spiral vessels, which lie imbedded in fibres of woody tissue and the cells above described.

The second membrane forms the chief substance and thickness of the husk.

The *third* membrane, thin and delicate, consists of angular cells of small size, the cavities of which contain minute globules of fat: in removing the outer tunics this membrane sometimes comes away in part with them, but in general the greater portion adheres to the surface of the seed. This membrane covers not only the outer surface of the lobes of the seed, but also dips down between them, and furnishes each of the opposite sides with a covering; it is most evident, however, on the external surface. It is probable, notwithstanding it may be exhibited as a separate tunic, that it is, strictly speaking, not to be regarded as a distinct structure, but that it really belongs to the seed, since on removing it cells belonging to the

Fig. 43.

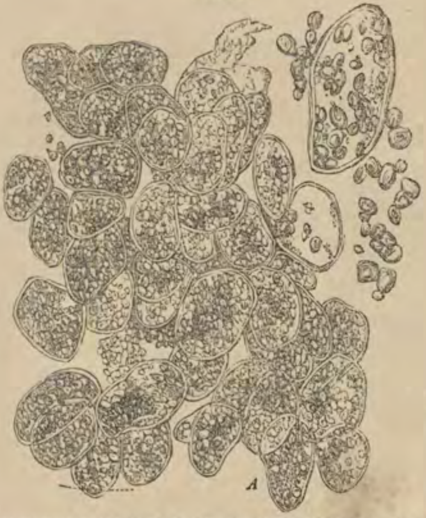


In this engraving the several structures above noticed are delineated. *a*, *third tunic*; *b*, *rounded cells*, derived from the second membrane, lying upon the fourth membrane, and situated at the lines of junction of the lobe; *c*, *fourth or fibrous membrane*; *d d*, *elongated bodies*; *e e*, *rounded masses of crystalline fatty matter*; *f f*, *crystals of margarine*.

substance of the seed frequently come away with it; the colourless cells constituting it being evidently gradually transformed into the coloured ones of the seed itself. To each seed-lobe, therefore, according to the above description, there is a distinct membrane.

Situated in the interspaces of the lobes is a fourth structure, attached externally to the second membrane, the cells forming which pass down upon it for a short distance; although clear and transparent, it exhibits a fibrous structure, and on its surface a considerable number of small crystals are always to be seen, as well as many elongated bodies, rounded at either extremity, and divided into several compartments or cells, and which do not appear to be attached to the membrane on which they lie. From their curious appearance, and the absence of connexion with any of the other structures of the cocoa seed, the observer is led to suspect that they are extraneous and probably fungoid growths. We have detected them in every sample of cocoa seed submitted to examination. See *fig*. 43.

Fig. 44.



This figure represents the *cells* which form the kernel of the seed. In *A*, the cells and contained starch corpuscles are magnified 220 diameters; and in *B*, 500 diameters.

We have now completed the description of the several structures which enter into the composition of the husk of cocoa.

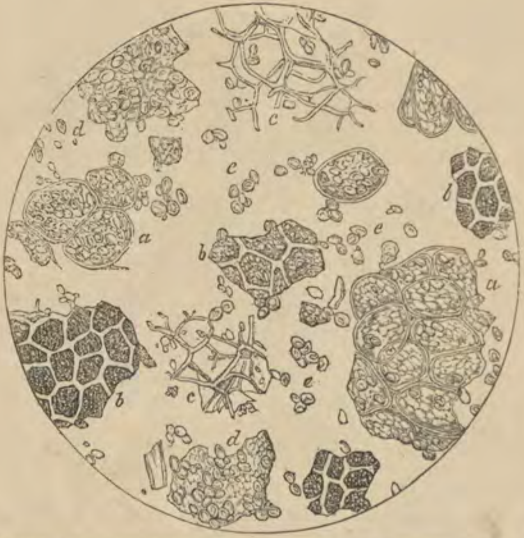
The *seed*, deprived of its husk, is seen to be composed of several lobes, angular in form, and irregular in size and shape; under pressure, these readily separate from each other, and the seed breaks up into pieces, which are known as "nibs."

The lobes are constituted of innumerable minute cells, of a rounded form, the cavities of which are filled with starch corpuscles and fatty matter.

On the surface of the seed these cells are rendered angular by compression, and are usually of a deep-red colour: the tint, however, varies greatly; they are frequently, in parts, spotted with purple, and even deep blue.

Each cell contains many starch corpuscles, small in size, of a rounded form, and which often present an obscure, radiate, or stellate hilum.

Fig. 45.



Represents the structures met with in a sample of GENUINE TRINIDAD COCOA. It will be noticed that *the tissues forming the husk of cocoa are absent*, and that those of the seed itself are much broken up, many of the cells being ruptured, so as to permit the escape of the starch corpuscles and fat, points of importance in the manufacture of chocolate. *a a*, cells of the kernel of cocoa; *b b*, membrane on surface of lobes; *c c*, tissues of embryo; *d d*, free masses of starch; *e e*, loose starch corpuscles.

Placed at one extremity of the seed is the *embryo;* this consists of cellular tissue, the cells or meshes of which enclose numerous starch granules and spherules of oil.

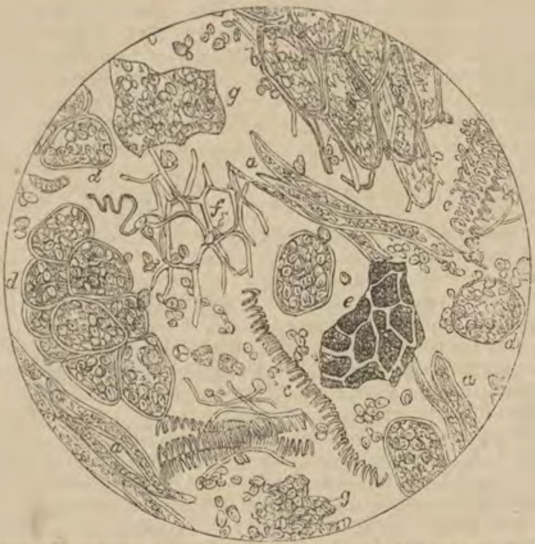
Now, in the more carefully prepared chocolates, the whole of the structures represented in *figs.* 40, 41, and 42. are absent, and those delineated in *fig.* 43., and especially *fig.* 44., only are met with: in some cases the embryo even is removed; but this, since it forms so inconsiderable a part of the entire seed, and contains, moreover, starch and fat, appears to be almost an over-refinement.

On the Properties of Cocoa.

Cocoa may be considered under two heads; as regards its *action* on the nervous and vascular systems, and as a direct nutritive.

The physiological actions of the aromatic oil of cocoa and of the theobromine are probably similar to those of the corresponding constituents of tea and coffee.

Fig. 67.



Exhibits the structures present in a sample of *unadulterated* FLAKED COCOA, which usually *contains both seed and husk*. *a a*, tubular fibres on surface ; *b b*, second membrane of husk ; *c c*, spiral vessels : *d d*, cells of kernel ; *e*, membrane covering lobes ; *f*, tissue of embryo ; *g g*, free masses of starch granules ; *h h*, loose starch corpuscles.

The special actions of the volatile oils of tea and cocoa have not yet been scientifically investigated ; those only of the oil of coffee have hitherto been made the subject of experiment ; but from analogy there is good reason for supposing that all these oils, which so closely resemble each other in their physical properties, agree also in all essential particulars in their physiological actions.

The volatile oil of coffee taken in moderate quantities, as already stated, produces a gentle excitement of the nervous and vascular systems, dispels hunger, retards the waste of the tissues to an equal extent with caffeine, and hence allays hunger.

The caffeine of coffee and of tea retards greatly the waste of the tissues, and hence is indirectly nutritious. This is shown by the diminution of the quantity of urea, phosphoric acid, and salt in the urine.

As a nutritive cocoa stands very much higher than either coffee or tea, in consequence of the large quantities of fat, starch, and gluten contained in it.

It is true that tea contains a larger proportion of gluten than cocoa, viz. 35 per cent., as compared with 20 per cent.; but most of this gluten, owing to the manner in which the infusion is prepared and drank, remains in the leaves, and the benefit of it is of course lost to the system. Again, tea does not contain butter or any considerable amount of starch. In the case of cocoa, an *emulsion* of the seed is made, and in this way all the active and nutritious constituents of the article are consumed. Owing to the large quantity of fatty matter present, cocoa is apt to disagree with some delicate stomachs.

On the Adulteration of Cocoa.

The roasted beans or seeds of cocoa, when ground and reduced to paste, constitute flake or rock cocoa, which consists, *when it is genuine, of nothing but cocoa.*

Other names under which cocoa is sold in this country are granulated, soluble, dietetic, homœopathic &c.

Now there is nothing in these names to indicate that the articles in question are anything more than varieties of cocoa, or to show, what is too frequently the case, that they are compounds of sugar, starch, cocoa, and oftentimes other substances.

The practice of calling these *mixed* articles cocoa is manifestly as improper and deceptive as it is to call *the compound of coffee and chicory*, Patent Compressed Coffee, Finest Old Turkey Coffee, &c.

An article should be sold for what it really is, and under its own name; if it be right to sell these mixtures at all they should be sold as the law now compels chicory and coffee to be sold, and should be labelled as mixtures. Further, the proportions of the several ingredients entering into the composition of the mixed article should be stated on the wrappers.

The French and other continental manufacturers of cocoa adopt a more straightforward and proper course: they never call their compound and manufactured articles cocoa, but chocolate; thus they even denominate the cakes which they prepare, and which contain nothing but cocoa, chocolate — "chocolat sans sucre," although, with strict propriety, they might in this case have used the word cocoa.

The cocoa, then, of the English makers in general is not cocoa at all, but chocolate; whenever, therefore, the word cocoa, an adjective of indefinite signification being prefixed, is employed to designate an article which is not pure or genuine cocoa, *that article ought to be considered as adulterated.*

The works of Accum, Brande, Ure, and Pereira contain but little information respecting the adulteration of cocoa; the only English writers who have treated of it at all fully being Mitchell and Normandy.

The first of these authors, Mitchell, has the following observations on the subject: —

"Chocolate is adulterated with flour, potato starch, and sugar, together with cocoa-nut oil, lard, or even tallow. Even the so-called finest chocolate is made up with clarified mutton suet and common sugar, together with ordinary cocoa.

"If in breaking chocolate it is gravelly, — if it melt in the mouth without leaving a cool, refreshing taste, — if it, on the addition of hot water, becomes thick and pasty, — and, lastly, if it form a gelatinous mass on cooling, it is adulterated with starch and such-like substances.

"Where earthy and other solid substances are deposited from chocolate mixed with water, either the beans have not been well cleansed, inferior sugar has been employed, or mineral substances have been added to it, either for the purpose of colouring or of increasing its weight.

"Moreover, when chocolate has a kind of cheesy taste, animal fat has been added; and when very rancid, either vegetable oil, or even the seeds themselves, have been employed in the sophistication.

"The mineral substances employed in the making up of chocolate are some of the ochres, both red and yellow, together with minium (red lead), vermilion, sulphate of lime, chalk, &c. Chocolate so adulterated, more especially with the preparations of lead, are highly injurious; it is, however, only the inferior chocolates that are thus adulterated."

From the work of Normandy we extract the following remarks: —

"Unfortunately, however, many of the preparations of the cocoa-nut sold under the names of chocolate, of cocoa flakes, and of chocolate powder, consist of a most disgusting mixture of bad or musty cocoa-nuts, with their shells, coarse sugar of the very lowest quality, ground with potato starch, old sea-biscuits, coarse branny flour, animal fat (generally tallow, or even greaves). I have known cocoa powder made of potato starch, moistened with a decoction of cocoa-nut shells, and sweetened with treacle; chocolate made of the same materials, with the additions of tallow and of ochre. I have also met with chocolate in which brick-dust or red ochre had been introduced to the extent of twelve per cent.; another sample contained twenty-two per cent. of peroxide of iron, the rest being starch, cocoa-nuts with their shells, and tallow. Messrs. Jules Garnier and Harel assert that cinnabar and red lead have been found in certain samples of chocolate, and that serious accidents had been caused by that diabolical adulteration. Genuine chocolate is of a dark brown colour; that which has been adulterated is generally redder, though this brighter hue is sometimes given to excellent chocolate, especially in Spain, by means of a little annato. This addition is unobjectionable, provided the annato is pure, which, however, is not always the case."

In defence of the practice of selling sugar, flour, and cocoa under the name of cocoa, it is alleged that these articles are *more soluble and more digestible* than cocoa is alone. In reference to these statements the following considerations present themselves.

When a cup of cocoa is made by pouring hot water upon it, the sugar of course dissolves, as when sugar is added to tea or coffee: it certainly has no effect whatever in making the cocoa more soluble or more digestible; and the consumer at all events might be left to add for himself as he does to his tea or coffee. The starch or farina usually added to cocoa, when boiling water is poured upon it, forms a paste or jelly, more or less thick. This serves to entangle the particles of cocoa oil, and to prevent part of the oil from ascending to the surface, and collecting there in droplets. In a cup of cocoa, therefore, for an equal quantity of cocoa, there is just as much oil as though no starch was present, although, it is true, part of the oil is concealed from view. We do not, therefore, perceive in what way the starch renders cocoa more digestible. Of course the more sugar and starch added to the cocoa, the less cocoa there is in the mixture and the less oil; but nearly the same end would be obtained by using less of genuine cocoa. Moreover, starch in the proportion of about 12 per cent. is one of the natural constituents of the cocoa bean.

But it may be granted, merely for the sake of argument, that the starch (the sugar is altogether out of the question) is really an improvement: it can only be so in certain proportions; yet when we come to analyse different preparations of cocoa, we find that the proportions of starch vary from 5 to 50 per cent., with the sugar from 80 to 90 per cent. Of course such large additions as these cannot possibly constitute improvements, nor do they; in fact, some of these mixtures have scarcely the flavour or even the smell of cocoa.

That these large additions of starch and sugar are not improvements, any body may satisfy himself by contrasting the smell and taste of a cup of cocoa made from genuine flake or rock cocoa, and one made from the ordinary mixed article.

Nevertheless, we do not go the length of stating that such mixtures ought not to be permitted; but we are of opinion that they ought to be sold as mixtures, and the proportions of the ingredients stated on the wrapper.

Nearly every kind of flour and starch, especially such as are inexpensive, is added to cocoa. In the cheaper descriptions of cocoa *wheat flour*, *potato starch*, *and sago meal* are chiefly used, as well as mixtures of them in different proportions; one dealer giving the preference to one kind of starch or mixture, another to another kind. In some of the more expensive cocoas *East Indian arrowroot* and *Tous les Mois*, or mixtures of these with the cheaper starches, are employed.

The quality of the sugar used varies from white lump to the inferior descriptions of brown and treacly sugar.

Now the excessive reduction of cocoa by means of sugar and starch sometimes renders the employment of animal fat necessary to give it a richer character; very commonly this reduction also further necessitates the use of coloured or ferruginous earths, as *Venetian red*, *umber*, and *bole Armenian*.

Mr. George Phillips, in evidence before the Parliamentary Committee on Adulteration, states: "In one case, where I succeeded in getting the proportions, from a manufacturer, of what he called his best soluble cocoa, there were, in his own language, cocoa forty-two, lump forty-two, white and red fifty-two. The cocoa represents the nut, the lump the sugar, and the white is starch; the red, oxide of iron to colour it. The per-centage of cocoa in that sample would be 30 per cent., and that was stated by the manufacturer to be his *best soluble cocoa.*" If that was his best cocoa, what, we wonder, was the composition of his worst?

It should be known that Venetian red and other ferruginous earths are sometimes contaminated with *arsenic.*

Results of the Examination of Samples.

We will now state *the results derived from the examination, chemical and microscopical, of a large number of samples of cocoa* of different kinds purchased from dealers resident in the metropolis.

The results of the examination of fifty-four samples of various kinds were,—

That *eight* samples were *genuine*, these being *flake* and *rock* cocoas; that is, they contained no sugar or starch, but consisted entirely of cocoa.

That *sugar* was present in forty-three samples, the amount forming from 5 to as much as, in some cases, 50 per cent. of the article.

That *starch* was detected in forty-six of the so-called cocoas, the amount likewise varying from 5 to 50 per cent.

To such an extent did some of the samples consist of sugar and starch, that they contained only sufficient cocoa to impart some degree of flavour to the articles.

Lastly, that out of sixty-eight samples of cocoa and chocolate, the ashes of which were submitted to examination, thirty-nine contained coloured earthy substances, as *reddle*, *Venetian red*, *umber*, &c.

When it is remembered that the relative prices of wheat flour, potato starch, and sago meal, also of sugar, especially brown sugar, bear so small a proportion to that of cocoa itself, it will be readily understood how great is the inducement to substitute these articles for cocoa; and it will, we are sure, be apparent that it is not out of simple regard to our digestive organs that they are added to cocoa in such large quantities.

The extent to which the adulteration of cocoa is carried may be to some extent judged of by the fact that the price at which some of the inferior cocoa mixtures are sold is much less than that at which genuine cocoa can be purchased.

The real secret of the almost constant use of starch and sugar is to be found in the cheapness of these articles, and not in any advantages supposed to be derived from their admixture with cocoa; this we shall now proceed to show.

Genuine cocoa, in the form of flake, rock, or roll, is sold at from 10*d.* to 1*s.* per pound; wheat flour may be purchased at 1½*d.*, potato flour and sago meal at about 3*d.* or 4*d.* per pound; sugar at from 3*d.* to 5*d.* per pound. The mixtures of cocoa, starch, and sugar, are sold at from 6*d.* to 2*s.* 8*d.* per pound; let the reader compare these prices with the cost of wheat and potato flours, and he will then perceive what a field for imposition and extortion the admixture of these substances with cocoa affords.

Setting aside, however, the question of price, and whether the admixture of starch with cocoa is attended with any advantages or not, on the same principle as we objected to the calling of the mixture of chicory and coffee—coffee, we also object to designating a compound of starch, sugar, and cocoa by the name of the latter only, no adjective being prefixed to the word cocoa, indicating the presence in the article of any other substances.

But there are other adulterations of cocoa sometimes practised, but which have not yet been referred to, viz., those with *chicory* and the *husk of cocoa.*

The cocoa beans are sometimes coarsely broken up into nibs, and are sold in this state; now these nibs are frequently adulterated with roasted chicory root.

Again, genuine cocoa of good quality ought not to contain any of the husk, which, as has been shown, forms about 12 per cent. of the seeds, and which is almost destitute of active or nutritious principles and substances.

Nevertheless the husk is almost constantly present in the cheaper cocoas of British fabrication: the French makers rarely make use of the husk, but sell it at about 3*d.* per lb.

The greater part of the husks not used in cocoa, Dr. Ure states, find their way into Ireland. Dr. Ure affirms that 612,123 lbs., out of 753,580 imported for consumption in 1840, were consumed in Ireland, and less than 4000 lbs. of the beans.

There is good evidence to show that in some cases the fragments of husk prove irritating to the intestines and occasion diarrhœa.

Johnston states: "This husk is usually ground up with the ordinary cocoas, but it is always separated in the manufacture of the purer chocolates. Hence, in the chocolate manufactories it accumulates in large quantities, which are imported into this country from Trieste and other Italian ports under the name of 'miserable.' Here the husk is partly ground up in the inferior cocoas, and is partly despatched to Ireland."

Before proceeding to point out the methods by which the various adulterations of cocoa may be discovered, a few remarks may be made on chocolate.

CHOCOLATE, AND ITS ADULTERATIONS.

Unlike cocoa, chocolate is, as is well known, a manufactured article; the French particularly excel in its preparation, making a variety of combinations of cocoa with other substances.

The more common additions are, however, sugar, and various kinds and mixtures of starch; in the better descriptions of chocolate, Maranta arrowroot is employed.

For imparting flavour and scent, vanilla and cinnamon are chiefly used.

Occasionally a medicinal chocolate is prepared with salep, a fecula obtained from the bulbous root of an orchis. In some cases, also, chocolate is made the vehicle for the administration of various remedies, the taste of which is to a great extent concealed by the chocolate.

Of twelve samples of chocolate examined,

One contained 13 parts of sugar and 25 parts of starch to the 100 parts; the starch consisted of a mixture of tapioca starch, Maranta arrowroot, Indian corn flour, and sago meal.

The *second*, of 35 parts sugar and 30 parts wheat flour to the 100 parts.

The *third*, of 13 parts sugar and 10 parts sago to the 100 parts.

The *fourth* sample, being obtained from the same maker, had the same composition as the first.

The *fifth* contained 15 per cent. of a mixture of wheat flour and potato starch, but no sugar.

The *sixth* contained 14 per cent. of sugar and 16 of potato flour.

The *seventh* consisted of 14 per cent. of sago meal, with a little sugar, the remainder being cocoa.

The *eighth* consisted of a mixture of *cocoa* and *sugar* made into a paste with water, the cocoa forming about 56 per cent. of the article, or little more than one half.

The composition of the *ninth*, *tenth*, and *eleventh* samples was nearly the same.

The *twelfth* sample consisted of a mixture of sugar, potato flour, sago meal, water, and cocoa. The sugar and water formed 42 parts of the article, the flour at least 10 parts; the cocoa thus formed less than half the article.

Besides the above ingredients, several of the chocolates contained *coloured ferruginous earths*. Generally the proportion of starch was much less than in some of the cocoas examined.

Chocolate being a compound article, no valid objection can be urged against the presence of sugar and starch. The points to be considered are, the price of the article, and the proportions and quality of the ingredients of which it is composed; the addition of the red earths of course cannot be justified.

On the Detection of the Adulterations of Cocoa.

The articles employed in the adulteration of cocoa, and with the means for the detection of which it is necessary that we should be acquainted, are the following: —*sugar*, *various flours* and *starches*, *husk of cocoa*, *chicory root*, *fatty matter*, and *coloured ferruginous earths*.

On the Detection of Sugar. — The presence of sugar in cocoa may be readily detected by the taste. To determine the quantity, the following simple but efficient proceeding may be adopted: — Dissolve a weighed quantity of cocoa containing sugar in cold water, filter, dry the residue first with blotting paper and then on the water-bath, weigh; the loss will indicate very nearly the amount of sugar with which the sample of cocoa operated upon was admixed.

To show to what extent this method may be relied upon, we may mention that we dissolved one ounce of a mixture in equal proportions of cocoa and sugar in cold water, and afterwards dried the residue; the weight of this was only twenty-eight grains short of the four drachms. Or the aqueous solution may be evaporated and the residue dried.

The method of determining the sugar by conversion into alcohol or carbonic acid is not well applicable to the cocoa mixture, because of the starch present. The sugar is cane sugar, and it is necessary that this should be converted into grape sugar by the action of dilute sulphuric acid in order to render it readily fermentable; but this acid also converts the starch present into sugar.

On the Detection of Starch. — In most cases it is sufficient to determine the kind of starch employed, and to form an approximate opinion as to the quantity present: the only certain method by which a knowledge of the kind of starch employed can be obtained is by means of the microscope. In some cases, however, it may be necessary to ascertain with tolerable accuracy the quantity of starch present.

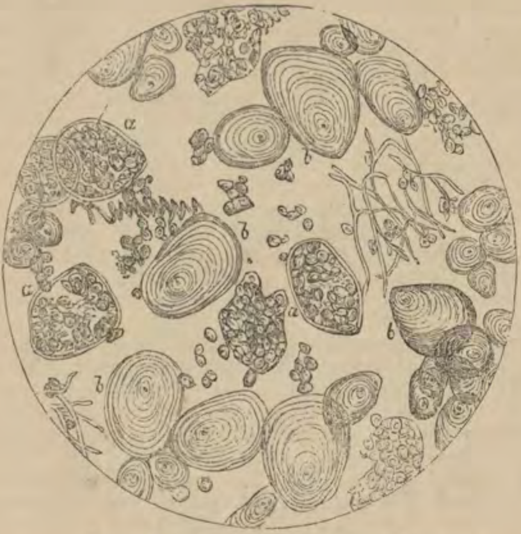
The starches employed in the adulteration of cocoa are the following: wheat flour, potato flour, Indian corn, sago meal, tapioca, East India, Maranta, and Tous les Mois arrowroots. Now all these starches possess distinctive characters by which they may be readily distinguished from each other by the aid of the microscope.

Cocoa itself contains about 11 per cent. of starch in the form of minute starch granules, entirely different in size and shape from those of cocoa: besides, these granules usually are not free, but are for the most part embedded in the cells of the cocoa or else in its butter.

Now although cocoa contains so much starch, the only means recommended for the discovery of the adulteration of cocoa with starch, was by iodine, which of course gives, if properly employed, indications of the presence of fecula in every case; and not a word was even hinted respecting the employment of the only means by which the different starches used could be identified,—namely, the microscope.

The characters of *wheat flour* will be minutely described under the head of Flour; but they have already been briefly noticed and represented when describing the adulterations of chicory and coffee. See *fig*. 30. p. 127.

Fig. 47.



Steane, Davis, & Co's Superior Soluble Cocoa.
a a a, starch corpuscles, cells, and spiral vessels of cocoa; *b b b*, granules of *potato flour*.

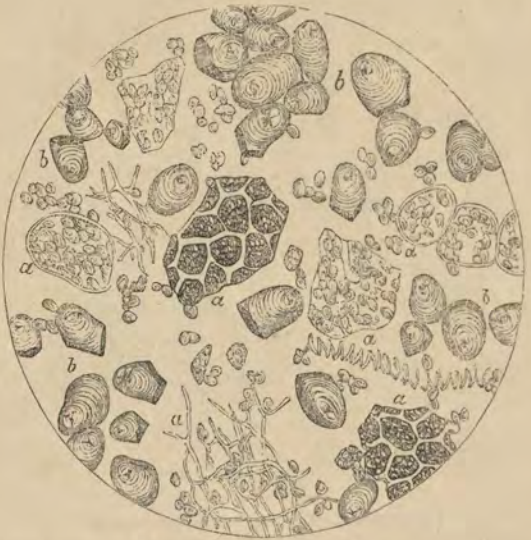
The characters of *potato flour* will be described under the head of Arrowroot. It may be stated now that they are of large size, ovate form, distinctly ringed, and with a small but very distinct hilum at the smaller extremity of each granule. They are well represented in *fig*. 47.

The characters of *sago meal* will also be given under the head of Arrowroot. The granules, although smaller than those of potato, are yet of considerable size; but they are particularly and easily distinguished by being truncate at one extremity, as represented in *fig*. 48.

In *fig*. 49. the starch granules of both *potato flour* and *sago meal* are figured: it will be seen that the differences are very considerable and obvious.

The starch granules of *Indian corn* are of about the size of those of wheat flour; but the greater number of them are polygonal, and hence they exhibit a more or less angular outline. See article Flour.

Fig. 48.



WHITE'S PURE HOMŒOPATHIC COCOA.
a a a, starch granules, cells, and fragments of cocoa; *b b b*, granules of *sago meal.*

The characters of the starch granules of Maranta or West Indian, Curcuma or East Indian, Tapioca or Manihot arrowroot, and of Tous les Mois, will likewise be found fully detailed in the article Arrowroot.

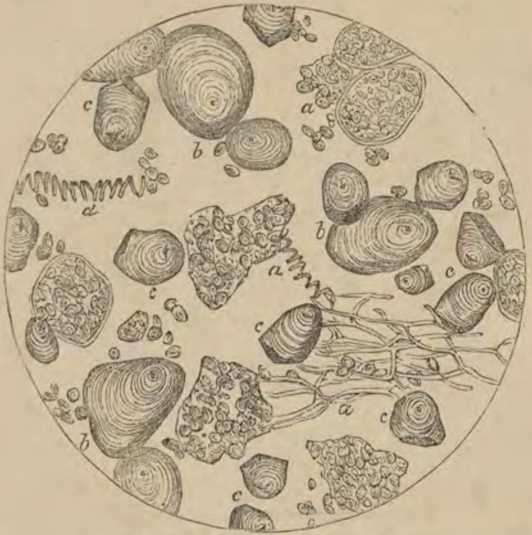
The granules of *East Indian arrowroot* are very flat; the striæ upon them describe segments or portions of rings only; and the central cavity is not visible.

The starch granules of *West Indian arrowroot* are of nearly the same size as those of sago starch. They differ, however, in not being muller-shaped, and in the slit hilum which runs transversely across the granule.

Those of *Tapioca arrowroot* are, like the starch granules of sago, muller-shaped, but they are several times smaller.

Lastly, the starch granules of *Tous les Mois* differ from all the others in being very much larger; they are flat, with strongly marked striæ, which describe segments of circles only, and they present a small but well-marked central hilum.

Fig. 49.



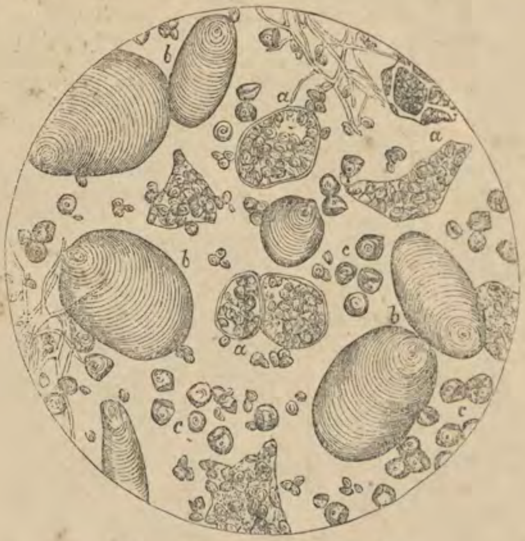
J. S. FRY & SONS' CELEBRATED SOLUBLE COCOA.
a a a, granules and cells of cocoa; *b b b*, granules of *potato flour*; *c c c*, granules of *sago meal.*

In order to determine approximately the quantity of starch present in any cocoa, probably one of the simplest methods is the following:— The sugar, if present, having been removed by means of cold water, the cocoa is to be boiled thoroughly, the decoction strained through coarse muslin, and the fat removed when cold: the residue which subsides from the strained liquid consists chiefly of starch, the amount of which may be determined either by measurement in graduated tubes, or else it may be dried and weighed.

In the latter case it is necessary to ascertain by previous experiment how much boiled and dried starch of each different flour or arrowroot corresponds to certain amounts of the raw flour or starch.

Some idea of the quantity of starch present may be formed from the consistency of the decoction when cold. If the amount of starch is very considerable,—40 or 50 per cent.,—the liquid will be thick and jelly-like.

Fig. 50.



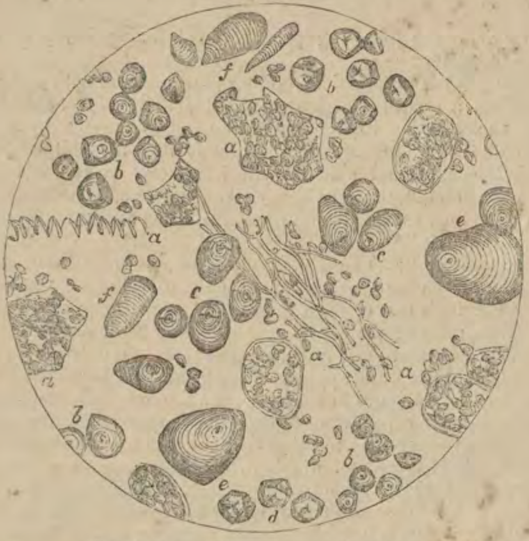
TAYLOR BROTHERS' HOMŒOPATHIC COCOA.
a a a, granules and cells of cocoa ; *b b b*, granules of *Canna starch* or *Tous les Mois;* *c c*, granules of *tapioca starch.*

In making observations on the comparative density of cold decoctions of cocoa containing different per-centages of starch, we noticed that after a time the starch ceased to be uniformly diffused throughout the fluid, and that it, as well as the heavier particles of cocoa, subsided, leaving a supernatant stratum of clear liquid ; this stratum varying in thickness according to the quantity of starch present, and being most shallow where there was most fecula, and deepest where this was least.

It then occurred to us that in the fact of the subsidence of the starch we had a means of determining approximately the per-centage of that substance present in any sample of cocoa.

We accordingly filled five tubular glasses, each seven inches and a half in height, three-fourths of an inch in diameter, and holding twelve drachms of water, with five different cold decoctions of cocoa, containing, respectively, 50, 40, 30, 20, and 10 per cent. each of starch: in the first, the thickness of the clear stratum was one inch ; in the second, one inch and a half; in the third, two inches ; in the fourth, two inches and a half; and in the fifth, three inches. It is to be understood, however, that these measurements are approximately

Fig. 51.



DUNN'S GENUINE UNADULTERATED CHOCOLATE.

a a a, starch granules and cells of cocoa; *b b b*, granules of *tapioca starch*; c c c, *Maranta arrowroot; d, Indian corn meal; e e, potato starch; f f, Curcuma arrowroot.*

correct only, and that to obtain perfectly accurate results it is necessary that the experiments should be carefully repeated. The proportion of the ingredients forming each decoction was 220 grains by weight of the mixture of cocoa and potato flour, to eight ounces of water, the boiling being continued for five minutes in each case.

Or the amount of starch present may be determined chemically. The sugar, should any be present, having been removed, and also the fat, either by expression or by the action of ether, the cocoa is to be dried and weighed, then treated—once or twice, as may be necessary—with a weak solution of potash, which will dissolve out the starch: the residue consists chiefly of woody fibre and cellular tissue; this is to be dried and weighed, and the difference between the first and second weights represents the amount of starch present. Another way is to boil the cocoa after the removal of the sugar and fat, and to precipitate the starch from the decoction by means of iodide of potassium; the blue iodide of starch is formed, from which the starch may be calculated. According to Brande iodide of starch has no certain composition; but by the analysis of Lorsaigne it appears that it contains 41·79 parts of iodine and 58·21 of starch; or, according to Berzelius, two atoms of iodine with one of starch.

Graham gives the following process for obtaining iodide of starch in a state of purity: —

"A firm jelly is prepared by boiling potato starch with water, and after cooling, a quantity of hydrochloric acid is added, sufficient to occasion the solution to become liquid, when assisted by a slight elevation of temperature. The solution is then filtered, and a solution of iodine in alcohol is mixed with it, so long as the latter produces a blue precipitate; care being taken not to add too much of the solution of iodine, as the alcohol of that solution will then precipitate uncombined starch." *

But the most accurate method is, after the removal of the sugar, to convert the starch into grape sugar, and to calculate the amount either by Fehling's test or from the alcohol or carbonic acid formed.

Take 200 grains of the cocoa mixture; boil with about ten times the quantity of water; add rather more than two drachms of dilute sulphuric acid (1 to 5), and apply heat until the fluid becomes thin; boil the fluid for 6 or 10 hours in a flask with a narrow neck, placed on the sand-bath, replacing from time to time the evaporated water; or heat the fluid from twenty-four to thirty-six hours in a water-bath. When the conversion is complete, which in ordinary cases may be ascertained by tincture of iodine, dilute the fluid with water, and determine the quantity of sugar present either by Fehling's test or, what is better, by converting it into alcohol and carbonic acid. Calculate the sugar from either of these, and the starch again from this. The composition and method of using Fehling's test is given elsewhere; 100 parts of grape sugar correspond to 90 parts of starch. The method of converting grape sugar into alcohol is described under the article Coffee, p. 123., and the fermentation test under Tobacco.

On the Detection of Foreign Fatty Matter. — Animal oils and fats, as lard, tallow, and suet, on exposure to the air for a time, especially in a warm place, become rancid and disagreeable to the taste, while the butter of cocoa under the same circumstances remains perfectly sweet.

For the detection of these adulterations, therefore, the cocoa or chocolate should be scraped fine and spread out in a thin layer on a plate, so that the air may have free access to it. In a few days the foreign fatty matters will have become rancid, when they may be detected by the taste and smell, especially when warmed.

Another way is the following, given by Dr. Normandy: —

"The presence of *animal fats*, or of *oils*, may also be recognised by saponifying a portion of the chocolate as follows: — Rasp about 2000 grains of the chocolate under examination, and boil them with water and some caustic potash. When the fat is saponified, dilute the mass with a sufficient quantity of water, and filter three or four times. The milky filtrate, which is, in fact, a solution of soap, should now be supersaturated with nitric acid; this will separate the fat, which will float on the liquor after cooling. It may then be collected on a filter; and on rubbing a small portion of it between the fingers, the odour will generally indicate its origin; but more effectually still by heating it in a small capsule. Pure butter of cocoa has no odour. Or the chocolate may be exhausted by sulphuric ether, and by evaporating it, the fat will be left behind, and may then be identified, as just said."

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* Elements of Chemistry, p. 742.

The presence of foreign fatty matter may sometimes be determined by noticing the form, size, and consistency of the droplets of fat or oil which collect on the surface of a decoction of cocoa after it has become cold. If these droplets be firm, shot-like, and globular, except on the upper surface, which is slightly flattened, and very small, rarely exceeding the twelfth of an inch in diameter, then there is no doubt but that the globules in question consist of the fat or butter of cocoa.

If, however, on the other hand, the globules be large, flat, or disc-like, exceed the size named considerably, attaining, some of them, to one-fourth of an inch, and even more in diameter, then animal fat or oil is probably present, a conclusion which may be still further confirmed by testing the fat, keeping it for a time, and observing whether it becomes rancid or not. The suspected cocoa should be cooled in an open vessel exposed freely to the air, and not in a covered one, for in this latter case the droplets of oil of even pure cocoa will frequently concrete in large and flattened dics.*

On the Detection of the Mineral Substances used.

Of the mineral substances employed in the adulteration of cocoa, some are used for the sake of their weight; of these the chief are *carbonate of lime* or *chalk*, and *sulphate of lime* or *plaster of Paris*, especially the former.

Other substances are employed for the colour they impart, and these are frequently had recourse to; the principal are red iron earths, as *red ochre*, *Venetian red*, and *umber*.

For the detection of these mineral substances 500 grains of the cocoa should be incinerated, and the ash weighed and analysed.

Some idea of the nature of the mineral substances mixed with the cocoa may be formed by dissolving a portion of it in boiling water, and observing closely the character of the precipitate. In this way the presence of ferruginous earth may sometimes be readily discovered.

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* Valuable information may often be obtained by ascertaining the melting point, which is different in the case of the butter of cocoa, and the fats employed for its adulteration.

For the detection of *carbonate of lime* and *sulphate of lime* we must proceed as described under the head of Tea, at p. 101.

The ash of genuine cocoa is pale grey: if any of the red iron earths be present it will be more or less coloured with the red oxide of iron; and in order to determine the quantity of this oxide, the process described in the articles on Tea and Chicory, at pp. 103. and 149., must be followed.

Red Ochre consists of oxide of iron with silica, and sometimes alumina, clay, or even chalk; while *Venetian red*, when genuine, consists of the sesquioxide of iron, and is obtained by calcining copperas or sulphate of iron. It is, however, often adulterated, especially with chalk.

It should be known that the colour of the ash obtained by the incineration of preparations of cocoa, adulterated with red ochre, is subject to considerable variation, dependent on the manner in which the incineration has been conducted, whether in an open or covered crucible, and according to the degree to which the ash has been heated and the length of time it has been subjected to the process. Thus the ash of cocoa so adulterated may be made to assume different colours, varying from dark brown, light brown, fawn, yellow, ferruginous yellow, up to rust-red, according to the method of incineration.

In some of the samples in which *clay* and *plaster of Paris* have been detected, these substances were not used for the sake of adding bulk or weight to the cocoa, the quantity present being too small; but they no doubt entered into the composition of the earthy colouring matters employed.

Alumina, if present, may be estimated from the soda or potash solution used to separate the alumina from the iron in the manner directed for the determination of alum in bread.

Duty 1*d*. per lb.
Cocoa and chocolate paste 2*d*. per lb.
Husks and shells 2*s*. per cwt.

		Lbs.
Home consumption	1854	4,563,782.
„	1855	4,471,561.
Nine months of	1856	2,336,625.— A great diminution.

The same nine months of 1855 3,482,370. lbs.

The following question, addressed to Mr. George Phillips, with the reply thereto, will show how admirably the Revenue is protected by the Excise against loss from the adulteration of cocoa.

Mr. Kinnaird. "Have you examined any cocoas?"

Reply. "Though that is under us, we have not much to do with it;" and then follows a statement of the inability of the Excise to detect Venetian red, or any other ferruginous earth, although this is one of the commonest of the adulterations to which cocoa is liable.

SUGAR, AND ITS ADULTERATIONS.

Two kinds of sugar have been particularly distinguished by chemists: namely, cane, and grape sugar or glucose. The first is obtained from the sugar cane, the beet root, the maple tree, and some other plants; while the second is contained in greater or less quantities in most fruits, and particularly in grapes, figs, and honey.

The chief part of the cane sugar of commerce is obtained from the sugar cane, *Saccharum officinarum*, of which there are several well marked varieties.

"Though almost unknown to the Greeks and Romans, and now cultivated most extensively in America, it is a native of the Old World. It was familiar in the East in most remote times, and appears to have been cultivated in China and the South Sea Islands long before the period of authentic history. Through Sicily and Spain it reached the Canary Islands; thence was transplanted to St. Domingo by the Spaniards in 1520; and from this island it has gradually spread over the West Indies, and the tropical regions of the American continent."—*Johnston.*

The sugar cane is one of the tribe of Grasses: it usually reaches a height of about 12 feet; it rarely ripens its seeds, and is therefore propagated from slips, which are planted in rows.

In some tropical regions the sugar cane (or rather its juice) forms an important and nutritious article of food. The ripe stalk of the plant is chewed and sucked, after being made soft by boring it; and enormous quantities are consumed in this way. "Large shiploads," states Johnston, "of raw sugar cane are daily brought to the markets of Manilla and Rio Janeiro; and it is plentiful in the market of New Orleans. In the Sandwich and many other islands of the Pacific every child has a piece of sugar cane in its mouth; while, in our own sugar colonies, the negroes become fat in crop time on the abundant juice of the ripening cane."

The nutritive properties of the raw juice of the sugar cane depend upon the circumstance that it contains, besides sugar, a considerable proportion of gluten.

The following is the process followed for the manufacture of sugar:—

The canes are cut down by means of large knives; the leaves and tops are chopped off and left in the field; the canes are carried to the mill, where they are crushed between heavy rollers which squeeze out the juice.

The juice is conveyed into large copper vessels, and is clarified chiefly by the addition of lime: the lime neutralises any free acids which may have formed, and also carries down with it the gluten. The juice is next boiled down, and is transferred to wooden vessels to crystallise. Finally, it is put into casks having certain perforations, to allow of the escape of the treacle or molasses.

Composition of the Sugar Cane.

The following are some of the chief analyses of the sugar cane which have hitherto been made: —

	Dupuy.	Peligot.	Avequin.	
			Tahiti Cane.	Ribbon Cane.
Sugar - - - - -	17·8	18·0	14·280	,13·392
Cellulose - - - - -	9·8	9·9	8·867	9·071
Mucilaginous, resinous, fatty, and albuminous matters	- -	- -	0·415 '	0·441
Salts, silica, iron - - -	0·4	- -	0·358	0·368
Water - - - - -	72·0	72·1	76·080	76·729
Fresh sugar cane - - -	100·0	100·0	100·000	100·000

The sugar cane, especially the violet variety, is coated with a peculiar kind of wax, termed *cerasine*, or sugar cane wax.

The following are the more important analyses of cane juice: —

	Avequin.	Peligot.	Playge.	Casaseca.
Sugar - - - -	15·784	20·90	20·8000	20·94
Various organic matters - -	0·140	·023	0·8317	·012
Salts - - - - - -	0·236	·017	Small quantities.	·014
Water - - - - - -	83·840	78·70	78·3325	78·80
	100·000	100·000	99·9642	100·000

It appears, therefore, from the above analyses, that cane sugar contains from 18 to 20 per cent. of saccharine matter; yet, owing to various circumstances, not more than 6 per cent., according to Johnston, is usually sent to market in the state of crystallised sugar.

The quantity of sugar present in cane juice may be estimated approximately by taking the specific gravity of the juice. Pereira states that it ranges from 1·067 to 1·106, and Mr. Fownes found it to vary from 1·070 to 1·090.

According to Fownes the juice has the following composition: —*Cane sugar*, a notable amount of *grape sugar* or *glucose*, *gum* or *dextrine*, *phosphates of lime* and *magnesia*, *some other salt of the same bases*, *sulphates* and *chlorides*, *potash* and *soda*; and lastly, *a peculiar azotised matter* forming an insoluble compound with lime, not coagulable by heat or acids, and readily putrefiable. Of ordinary *vegetable albumen* there are but indistinct traces, and of *caseine* or *legumine* none.

The *brown sugar* of commerce has the following composition

Although consisting chiefly of cane or crystallisable sugar, it yet contains a good deal of glucose, and is contaminated by various organic and mineral substances. According to Avequin its mineral constituents are silica, phosphate and subphosphate of lime, carbonate of lime, sulphate of potash, chloride of potassium, and the acetates of potash and lime.

Owing to these impurities it reddens litmus, and is not completely dissolved by alcohol; its solution furnishes precipitates with diacetate of lead, acetic acid, and caustic ammonia, and it is frequently darkened by the addition of sesquichloride of iron. By keeping it becomes weak, that is less sweet, soft, clammy, and gummy, — changes ascribed to the action of the lime.

Ordinary brown sugar, prepared from juice which has not been subjected to filtration, contains almost invariably a great many fragments of the tissue of the sugar cane, sporules of a fungus, and animalculæ to be described hereafter.

From white or refined sugar the above organic impurities are absent.

The crystals of sugar are double oblique prisms. *Fig.* 52. p. 184.

The following are the properties of cane sugar: —

It is the sweetest of all the sugars; when pure it is white and odourless; it is soluble in rectified spirit, but not in ether; its watery solution, aided by heat, decomposes the metallic salts of copper, mercury, gold, and silver; its watery solution with yeast undergoes the vinous fermentation; sugar promotes the solubility of lime in water, and it forms both a soluble and an insoluble compound with oxide of lead. Lump or refined sugar is permanent in the air, and phosphorescent in the dark and when struck or rubbed.

In the preparation of barley sugar, acidulated drops, &c., the confectioners usually add a small quantity of cream of tartar to the melted sugar, in order to destroy the tendency to crystallisation.

Crystallised sugar melts at 356° F., and at a higher temperature it begins to give off water, and to suffer decomposition; and if the heat is still more increased it loses its sweetness and becomes bitter, when it is called burnt sugar or *caramel.*

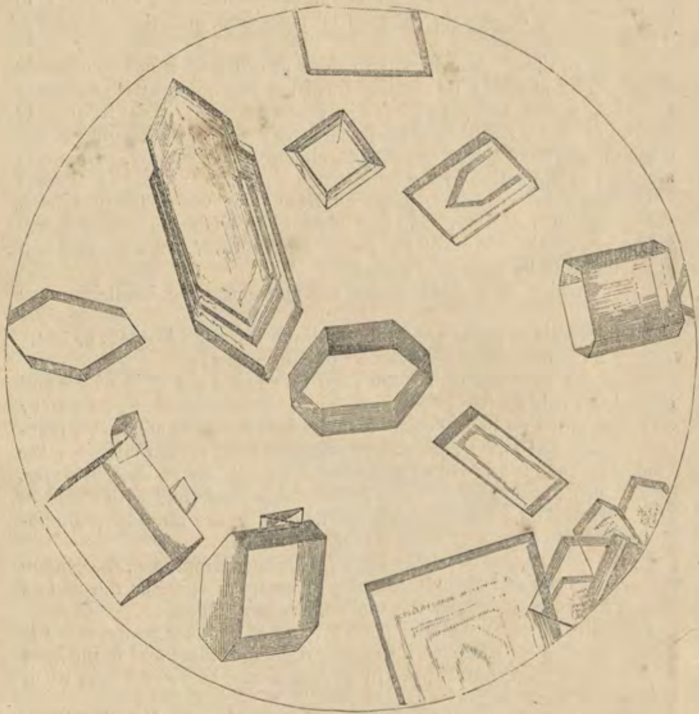
Although molasses and treacle are usually described as the same, it yet appears that they are really distinct, if not in their general composition, at all events in origin. They both consist of glucose, cane sugar, gum, gluten, extractive, various salts, and water.

Molasses consists of the drainings from raw or Muscovado sugar. West India molasses is sometimes imported for refining. It furnishes brown or bastard sugar and treacle.

Treacle is the syrup which drains from refined sugar. It has generally a sp. gr. of 1·4. Payen regards it as a saturated solution of crystallisable sugar, of which it contains from 40 to 50 per cent.

Cane sugar is distinguished from grape sugar by its crystallisability, its greater sweetness and solubility, in being reduced to charcoal by sulphuric acid; but being unchanged when treated with caustic potash, and by the greater difficulty with which it reduces the blue hydrated oxide of copper to the state of the orange suboxide.

Fig. 52.



Crystals of CANE SUGAR. 100 diameters.

Another character by which a solution of cane sugar is distinguished from that of grape sugar, is the property which it possesses of *right-handed* circular polarisation.

On the Structure of the Sugar Cane.

On the Presence of Fragments of Sugar Cane in Sugar.—The juice of the cane is expressed by means of powerful machinery, and during the operation innumerable fragments of the cane itself, many of them of extreme minuteness, become detached, and pass into the juice. As this in its manufacture into sugar does not undergo in general any process of filtration, and as but few of the fragments drain away with the treacle, the greater part of them are retained in the sugar, in all unfiltered samples of which they may be readily detected in great abundance by means of the microscope.

For the more ready and certain identification of these fragments, it is necessary to give a short outline of the structure of the sugar cane itself.

The sugar cane belongs to the class of Endogens, and consists of nearly cylindrical rods or stems, which are divided into joints at irregular distances of some three or four inches, and its structure is made up of cellular tissue, woody fibre, vessels, and epidermis.

The *parenchyma*, or *cellular tissue*, forms the most considerable portion of the sugar cane, and it is constituted of aggregations of infinite numbers of utricles or cells, in the cavities of which the juice is enclosed.

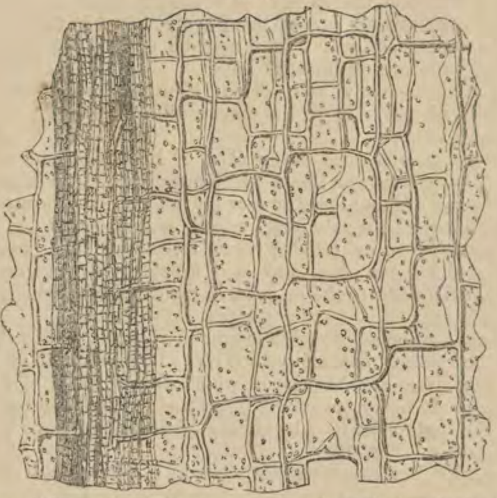
These cells are usually rather longer than broad, and in the central parts of the bamboo they are several times larger than in its outer and harder part; the membranes of which the walls of the cells are formed, are all finely dotted or punctated, a character by which the cells of the sugar cane may be clearly distinguished from most other vegetable cells. *Fig.* 53.

The *woody fibre* traverses the cane in a longitudinal direction in distinct bundles, which give to transverse sections a dotted appearance. Each bundle is constituted of a number of greatly elongated cells, and sometimes encloses vessels; these are also usually more or less dotted, like the ordinary cells of the parenchyma, of which, indeed, they are merely modifications. *Fig.* 53.

The *vessels* follow the same disposition as the woody fibre, in the centre of each bundle of which one or more is generally included. These vessels are of two kinds: the one is the interrupted spiral or dotted vessel, and the other the simple or continuous spiral vessel. The dotted vessels are sometimes cylindrical, but frequently polygonal, from the compression exerted upon them by the woody fibre, by which they are immediately surrounded, and the markings of the cells forming which they frequently exhibit on their surfaces: the spiral vessels are found chiefly in the outer and harder part of the stem; they are formed of a single thread, remarkable for its thickness and strength. *Fig.* 54.

The *epidermis* or *cuticle* is known by the elongated, crenate cells, of which it is composed, and the presence of stomata. At the distal extremity of each internode of the cane, the ordinary epidermic cells are replaced or overlaid by a layer of cells, having totally different characters; they are usually little longer than broad, more or less rounded or oval in shape, with their edges marked with short and well-defined lines, disposed in a radiate manner: these cells resemble somewhat the cells found in the stones of fruit, and they form by their union a zone round the cane, polished, hard, and of about the third of an inch in depth. *Fig. 55.*

Fig. 53.



A fragment of SUGAR CANE, taken from near the centre of the stem, showing the size and character of the cells of which the parenchyma is formed, as well as, on the left, a bundle of woody fibre. Drawn with the Camera Lucida, and magnified 100 diameters.

Fragments of sugar cane are present in great quantity in Muscovado sugar, in the sugars of the shops in general, and in "bastards," a product of the manufacture of loaf sugar.

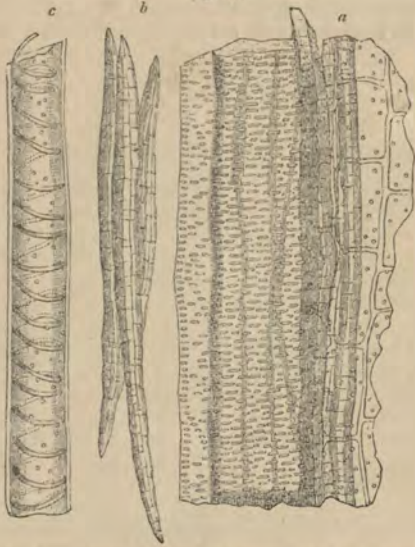
They are not contained in loaf sugar, crushed lump, sugar candy, nor in certain of the East Indian sugars: in the preparation of all these sugars the cane juice undergoes a process of filtration which effectually removes all solid and bulky impurities.

The presence of these fragments, in many cases, serves to distinguish satisfactorily cane sugar from either beet, maple, or grape sugar, a discrimination which otherwise it would be extremely difficult to effect.

By the same means, also, cane sugar may be detected when mixed with beet, a practice which, we believe, is not uncommon in France.

The saccharine juice of the beet root is filtered, and therefore fragments of that plant are not present in the sugar made from it, as they would doubtless be, were this means of purification not adopted.

Fig. 54.



Fragments of the SUGAR CANE, exhibiting the structure of the two kinds of vessels which enter into its composition, as well as the cells of which the woody fibre is constituted. *a*, *Dotted vessel* embedded in woody fibre; *b*, cells of *woody fibre*; *c*, *spiral vessel*. Drawn with the Camera Lucida, and magnified 200 diameters.

The presence of sugar cane in sugar increases the bulk and weight of the article, lessens its sweetness, and thus deteriorates both its quality and value.

Physiological Action and Properties of Cane Sugar.

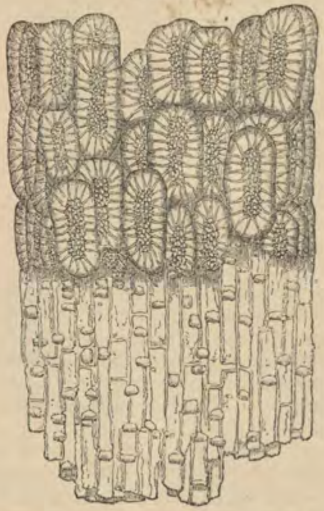
Sugar contributes to the formation of fat and lactic acid; it supplies material for the maintenance of respiration; and by its oxidation it furnishes heat to the system. Sugar and especially treacle have an aperient tendency.

In 1853 the home consumption of raw sugar amounted to 818 millions of lbs. This is equal to 28 lbs. of sugar for each person resident in Great Britain; but since the average consumption of Ireland is not more than one third that of England, the consumption per head in the latter country must be considerably over 28 lbs.

On the Adulterations of Cane Sugar.

Various adulterations have been stated to be practised on sugar ; as with *potato sugar*, *starch*, *gum* or *dextrine*, finely *powdered marble*, *chalk* or *whiting*, *sand*, *bone-dust*, and *common salt*.

Fig. 55.



A portion of the Epidermis of the Cane, showing the two kinds of cells of which it is composed — viz., those of which the general surface of the cane is formed, and those of which the polished zone described in the text is chiefly constituted. Drawn with the Camera Lucida, and magnified 200 diameters.

Sugar being soluble in water, it is obvious that were it to be adulterated with any insoluble substances, the discovery of such adulterations would be very easy and certain, for the only thing necessary would be to dissolve a portion of the sugar and to examine the precipitates which subsided.

We have examined over 100 samples of sugar, and the only insoluble substance, excluding accidental impurities, which we have met with, has been starch, which was present in small quantities in four samples. There is, therefore, but little foundation for the tales we hear about the presence of sand in sugar.

Formerly, however, when sugar was much dearer than at present, it used to be extensively adulterated with an inferior description of sugar made from potato starch by the action upon it of dilute sulphuric acid. But this adulteration has, we believe, ceased.

"A few years ago," writes Dr. Pereira, "I inspected an extensive manufactory of sugar from potato starch at Stratford, in Essex: the sugar obtained was sold for the adulteration of brown sugar, and the molasses produced was consumed in an oxalic acid manufactory." *

There is a practice, termed the "Mixing" or "Handling" of sugar, which, although not an adulteration, may here be described. It consists in mixing together, in various proportions, sugar of different qualities and prices,—as moist sugars with dry ones, very brown sugars with those of light colour,—the resulting article presenting a tolerable appearance to the eye, but being rarely what it professes to be — real Jamaica or Demerara sugar.

In reference to this subject some remarks from the work of Dr. Scoffern on the manufacture of sugar may be quoted.

"If the West Indian sugar-growers were to be furnished at once with a never failing means of producing a large-grained, and therefore an easily cured, sugar, to the exclusion of all other sorts, their produce would have to encounter a difficulty which the consumer would scarcely imagine. Such large-grained sugars are very unfavourable to the perpetration of certain mysterious operations of legerdemain †, which grocers understand too well. They will not mix. A small-grained sugar may readily be incorporated with glucose, with pieces or bastards, and other less innocent bodies, without such incorporation being discoverable to the eye. A large-grained sugar, on the other hand, is a most refractory material for these little manipulations; its crystals, no matter how mingled with contaminating agents, never ceasing to manifest their native brilliancy, and thus proclaiming the fraud. It is most easy, then, to understand why the grocer, as a rule, does not encourage these large-grained sugars. He cannot '*handle*' them, and therefore brands them with a fault. He says they are deficient in saccharine matter — that they will not sweeten. True it is, that comparatively small portions of these large-grained sugars are sold, and sold at high prices, but merely as fancy articles, on the proceeds of which the grocer nets too little to make their sale an object of primary solicitude.

"Such is the source of one prejudice against dry and large-grained sugars — a prejudice originating amongst the grocers. There is also another, which originates amongst refiners, who are adverse to the general consumption of these beautiful colonial sugars, for the very obvious reason that the consumption of their own staple is thereby lessened."

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* *Mr. Alderman Cubitt.* "Is there much potato sugar made?"—"A year or two ago, when there were diseased potatoes, there were tons made in a week at one establishment I visited. The disease in the potatoes did not touch the starch."—*Letheby* in Evidence before Committee on Adulteration.

† Termed by grocers, "*handling*."

Now nearly all the *brown* sugars of commerce, although *not often adulterated*, are yet in a very impure state. Thus many of them contain a good deal of treacle and glucose; and all, *fragments of sugar cane, sporules of a fungus*, and also large numbers of an insect termed an *acarus*.

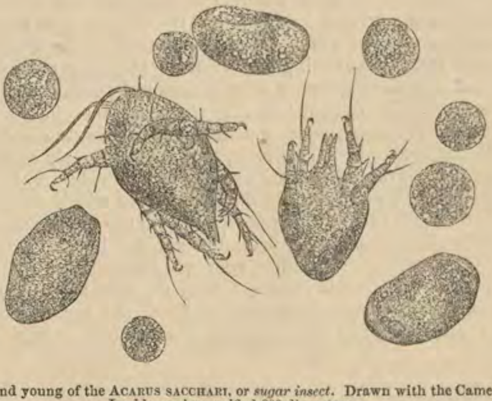
The presence of these various and damaging impurities is thus explained.

The presence of the fragments of cane is accounted for by the cane juice not having been filtered, of the fungus and of the insects, by the fermentation of the sugar, and the presence of nitrogenous matter. In sugars which have been filtered none of these impurities are met with.

The Sugar Mite. — The sugar mite or *Acarus sacchari* is in size so considerable, that it is plainly visible to the unaided sight. When present in sugar, it may always be detected by the following proceeding: — Two or three drachms or teaspoonfuls of sugar should be dissolved in a large wine-glass of tepid water, and the solution allowed to remain at rest for an hour or so; at the end of that time the animalcules will be found, some on the surface of the liquid, some adhering to the sides of the glass, and others at the bottom, mixed up with the copious and dark sediment, formed of fragments of cane, woody fibre, grit, dirt, and starch granules, which usually subsides on the solution of even a small quantity of sugar in water.

We will now proceed to give a description of the acarus in question, and observe, in the first place, that the whole of its development may be clearly traced out in almost every sample of brown sugar.

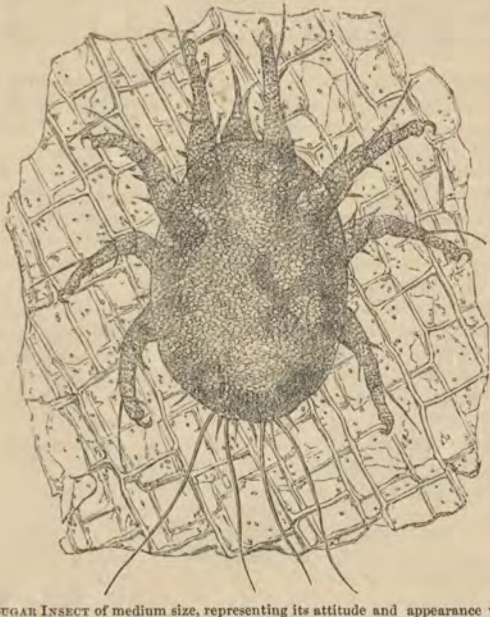
Fig. 56.



Ova and young of the ACARUS SACCHARI, or *sugar insect*. Drawn with the Camera Lucida, and magnified 200 diameters.

The *Acarus sacchari* is first visible as a rounded body, or egg; this gradually enlarges and becomes elongated and cylindrical until it is about twice as long as broad; after a time, from the sides, and one extremity of this ovum, the legs and proboscis begin to protrude. These stages of the development of the acarus are exhibited in *fig.* 56.

Fig. 57.

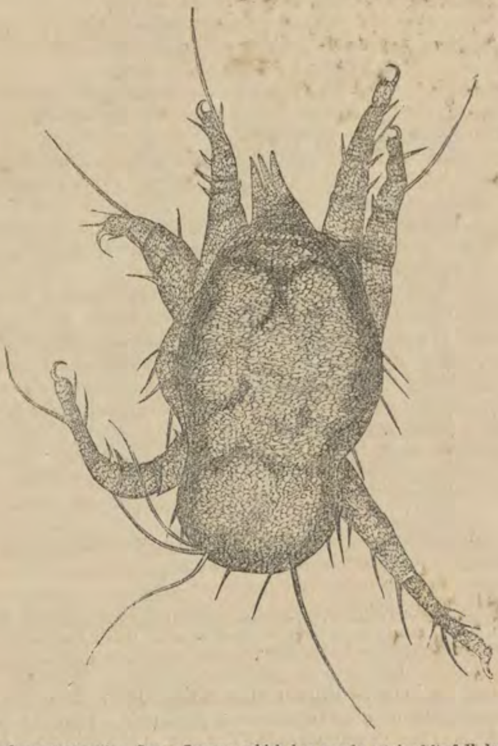


A SUGAR INSECT of medium size, representing its attitude and appearance when alive, and as seen crawling on a fragment of cane. Drawn with the Camera Lucida, and magnified 200 diameters.

The acarus thus far formed, goes on increasing in size until it attains its full growth, when it is visible to the naked eye as a mere speck.

In its perfect state, its structure is as follows: — The body is oval, or rather somewhat ovate, being broader behind than before; from its posterior part, four long and stiff bristles proceed, two together on each side; and some eight or ten smaller ones are arranged nearly at equal distances around the circumference of the body; from its anterior part a proboscis of complex organisation proceeds, and from its inferior surface eight legs, jointed and furnished with spines or hairs at each articulation; the spine which issues from the last joint but one of each leg is very long, and extends much beyond the termination of the leg itself; lastly, each leg is armed at its extremity with a formidable hook.

Fig. 58.



This figure represents a Sugar Insect, which has nearly attained its full development, and as it frequently appears when dead. Drawn with the Camera Lucida, and magnified 200 diameters.

Many of the above particulars are faithfully exhibited in the engravings.

In most samples of sugar the acari may be seen of all sizes, that is, in all the stages of their growth and in every condition; some alive, others dead; some entire, and others broken into fragments; bodies here, legs there.

We have said that the sugar mite is very commonly present in the less pure sugars—we might have asserted that it is almost constantly so, the statement being based upon the examination of not less than *one hundred* different samples of sugar.

As a rule the number of acari present in any sample of sugar may be taken as a fair indication of the purity of that sugar; the purer the sugar, the freer it will be from the sugar mite.

Grocers' Itch.—It is well known that grocers are subject to an affection of the skin, denominated "grocers' itch," of which one of the symptoms is extreme irritation and itching.

To this disease all grocers are not equally liable, but those more particularly who are engaged in the "handling" of the sugars, as the warehousemen.

Now the *Acarus sacchari* actually belongs to the same genus as the *Acarus scabiei*, or itch-insect, than which, however, it is larger, and possessed of an organisation still more formidable.

It thus becomes extremely probable that the disease in question does really arise from the sugar acarus—a point, however, which nothing short of microscopic observation can satisfactorily determine.

On Sporules of Fungi in Sugar.—Innumerable sporules of fungi are very generally to be observed in the less pure kinds of sugar; they occur, indeed, most abundantly in those sugars which favour the development of the acari.

They are best seen by dissolving a small quantity of any brown sugar in water, and looking for them in the sediment which subsides, and which, to a great extent, is constituted of the sporules in question.

These sporules are exceedingly minute bodies, usually of an oval form, and either floating singly in the sugar solution, or else adhering together, and thus forming little beaded threads. Under favourable circumstances the sporules become developed into perfect plants or fungi.

Another impurity very frequently met with in lump sugar, consists of *minute sawdust-like fragments*, not only of deal, but also of other woods; they often occur in great abundance, and of their presence it is not easy to give a satisfactory explanation. Possibly they are derived from the board on which the loaf sugar is broken into lumps.

Out of *seventy-two samples* of *brown sugar*, as procured at different shops, subjected to examination, *fragments of sugar cane* were present in all but one. These were usually so small that they were visible only by the aid of the microscope.

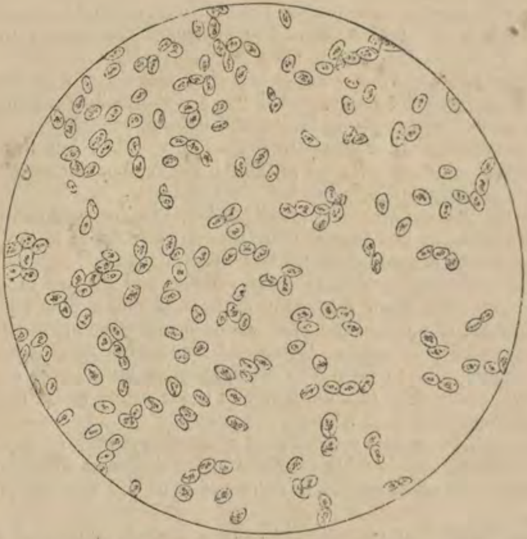
Sporules and *filaments of fungus* were present in nearly all the sugars.

The acari were present in sixty-nine of the samples, and in many in very considerable quantities.

Grape sugar was detected in all the sugars.

Four of the sugars contained proportions of *starch* so considerable as to lead to the inference that they were adulterated.

Fig. 59.



Sporules of the Fungus found in brown sugar. Drawn with the Camera Lucida, and magnified 420 diameters.

Eleven other samples of brown sugar, as imported from the East and West Indies, furnished nearly similar results. Two only could be regarded as pure and fit for human consumption,—a white, large-grained Calcutta sugar, resembling crushed lump; and a pale straw-coloured, large-grained, highly crystalline sugar from Cassipore. Both these sugars had no doubt been made from juice purified by filtration.

The results of the examination of *fifteen samples of lump sugar* were,—

That in none of the sugars were fragments of cane present.

That in three of the sugars only were traces of grape sugar to be detected.

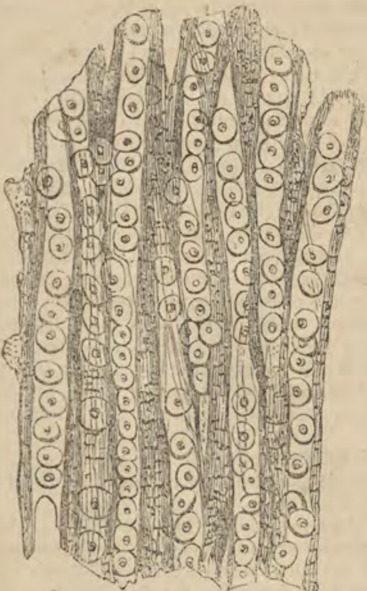
That in no case were acari observed.

That in none of the sugars were sporules and threads of fungi visible.

It has now been shown that the majority of brown sugars, although not adulterated, are yet, as imported into this country and as vended to the public, in an exceedingly impure condition.

These impurities prevail to such an extent, and are of such a nature, — consisting of live animalculæ or acari, sporules of fungus, grit, woody fibre, &c., — that we feel compelled, however reluctantly, to come to the conclusion, that *the brown sugars of commerce are, in general, in a state unfit for human consumption.*

Fig. 60.



A fragment of woody fibre of the FIR, showing its structure. Drawn with the Camera Lucida, and magnified 200 diameters.

We strongly urge the sugar refiner to prepare cheap forms of purified sugar, in powder, analogous to crushed lump; such sugars, we are informed, are extensively employed in Scotland, and we doubt not but that they would meet with a large and ready sale in this country.

On the Detection of the Adulterations of Sugar.

The adulterations which either are or have been practised upon sugar are those with starch and starch sugar.

Other articles alleged to have been used for its adulteration are gum or dextrine, chalk or whiting, gypsum, sand, bone dust, and common salt. These substances, except the gum and salt, are all insoluble in water: for their separation and identification nothing more in general would be necessary than to dissolve a portion of the sugar, to allow the precipitate to subside, and to examine it with the eye, and occasionally by chemical reagents.

If the precipitate be earthy, and if, on adding a little nitrate of silver to a portion of it, it turns yellow, it consists in all probability of bone dust or phosphate of lime: if, on the addition of an acid, it effervesce, it then consists of carbonate of lime, or chalk: should carbonic acid not be evolved, we may then test for gypsum: if the precipitate is composed of sand, it may at once be identified by the eye alone.

For the estimation of the above substances quantitatively, — rarely required, however,—a weighed portion of the sugar should be dissolved, and the precipitate, after being dried, should itself be weighed. But as in a solution of sugar part of the lime is held dissolved, in this case it is better to estimate the quantity of this present from the ash: this is effected by the process described under the head of Tea.

Salt, when present, which it rarely is, must likewise be estimated from the ash; a solution of this in distilled water must be made, and the chloride of silver —precipitated by solution of nitrate of silver— formed must be collected, dried, and weighed, and the chlorine contained in this calculated; this again must be estimated for chloride of sodium.

If the sugar is adulterated with *gum* we must proceed as follows: the sugar must be dissolved out by means of rectified spirit; the gum will be left behind.

Farinaceous substances may be thus detected: — The sugar must be dissolved, the precipitate examined with the microscope, and the characters of the starch corpuscles noticed. Boiled starch is scarcely likely to be employed; but if so, a precipitate would still occur in a solution of sugar: in this the remains of the starch corpuscles would still be visible, and with iodine it would turn blue. For the quantitative estimation of starch or farinaceous substances the precipitates must be dried and weighed.

Dextrine, a substance intermediate in its character between gum and starch, is detected by testing a solution of the sugar when cold with iodine, which gives a purplish colour, and also by the characters of the remnants of starch corpuscles still visible.

Lastly, we have to consider the means by which the adulteration of cane with starch sugar may be discovered.

Starch sugar is one form of grape sugar; and since, as we have shown, grape sugar is present from natural causes, in greater or less amount, in all the brown sugars of commerce, it is evident the analysis necessary to enable the chemist to state whether a sugar is adulterated with starch sugar or not must be a quantitative one, and that he is only justified in concluding that a sugar is adulterated with that substance when the proportion discovered forms a considerable per-centage of the whole article.

The tests ordinarily employed for the detection of grape sugar are Trommer's or the copper test, and the potash orMoore's test. A solution of grape sugar to which a solution of caustic potash has been added in excess, when boiled becomes of a deep rich brown colour.

Trommer's test consists of sulphate of copper and liquor potassæ. When these are added in certain proportions to a solution of grape sugar, and heat is applied, the red suboxide of copper is thrown down. Several modifications of this test have been suggested; the most important of them is that which is called Fehling's test.

There are two methods by which the quantity of grape sugar is determined.

By one method the quantity is estimated from the amount of a solution of definite strength required to precipitate all the sugar, a certain measure of the solution corresponding to one grain of sugar.

By the other method, the sugar is calculated from the suboxide precipitated, the solution being added in excess.

The copper test is used qualitatively in the following manner:—A drop or two of a solution of sulphate of copper is added to the solution of sugar, then solution of caustic potash in excess, and the mixture boiled, heat being applied to the upper part of the mixture in the test tube.

Fehling's test liquor is prepared as follows:—

Dissolve 69 grains of pure crystallised sulphate of copper in 276 grains of distilled water; to this add 276 grains of a saturated solution of tartrate of potash, then add 80 grains of hydrate of soda, previously dissolved in one ounce of distilled water; shake all well together, and introduce the liquor into a vessel capable of holding 2000 grains, graduated into 1000 equal parts, and fill up with distilled water. Every 200 grains, or 100 parts, of this test liquor are sufficient to decompose one grain of glucose. It is best to add excess of the solution, and to weigh the red suboxide thrown down.

In this case, the solution of sugar to which excess of the test solution has been added, should be gently heated on a sand-bath, till the suboxide has subsided; this should be collected by decantation, washed with boiling water, dried and weighed, and the sugar deduced from it. One hundred parts of anhydrous grape sugar corresponds to 198·2, or, according to Neubauer, 201·62 of suboxide of copper.

In employing the test quantitatively, the solution must be added little by little, until no further precipitate of suboxide occurs.

The solution should be kept in a dark place; and if it has been made for any time before using it, it should be boiled with water in the proportion of one part of the solution to four of water. If this operation causes the separation of even the smallest quantity of suboxide, the solution is unfit for use.

The sugar solution should be very dilute, and not contain more than one per cent. of sugar.

It must be remembered that the separated suboxide of copper will gradually dissolve in the supernatant liquor as soon as this becomes cold, as oxide, into which it is converted by the oxygen of the atmosphere, and hence the necessity of washing the precipitate by decantation in boiling water.

In this article, as in tea and coffee, the war not only arrested the fall of the duty, but occasioned a retrogressive move. The scale of duty on all sugar alike is now :—

	Till 5th of April, 1857.	Till 5th of April, 1858.	Thereafter.
	£ s. d.	s. d.	s. d.
Candy, Brown or White refined, or any equal in quality thereto - -	1 0 0	16 8	13 4
White clayed or equal, but not equal refined - -	17 6	14 7	11 8
Yellow Muscovado - -	15 0	12 9	10 6
Brown „ - -	13 9	11 8	9 6
Molasses - - - -	5 4	4 6	3 9

Consumption of all Sorts in 1854.

Unrefined - - - -	8,100,423 cwts.
Refined - - - -	304,128 „
Molasses - - - -	929,811 „

In 1855.

Unrefined - - - -	7,396,029 „
Refined - - - -	288,751 „
Molasses - - - -	921,574 „

Nine Months of 1856.

Unrefined - - - -	5,463,488 „
Refined - - - -	215,918 „
Molasses - - - -	684,638 „

Being all lower than the same months of 1855, owing to higher price and higher duty.

HONEY, AND ITS ADULTERATIONS.

Honey consists of the saccharine exudation from the nectaries of flowers collected by the bees, and modified and elaborated by them in the crop or honey bag, which is an expansion of the œsophagus, and from which it is discharged on their return to the hive, and deposited in the various cells of the comb.

It consists of *grape sugar*, *manna*, *gum*, *mucilage*, *extractive*, a little *wax*, *pollen*, *acid*, and *odoriferous substances*.

Honey usually consists of two parts, one fluid, the other solid and crystalline. By pressure in a linen bag, these may be separated from each other, a clear syrupy substance passing through the linen, and the white solid sugar remaining behind.

"Both the solid and liquid sugars have the same general properties. They are both equally sweet, both have the same chemical composition, and both begin to ferment when water and a little yeast are added to them." — *Johnston.*

In old honey the proportion of solid sugar is the greatest.

"The solid sugar of honey is probably identical with the sugar of the grape: the liquid sugar differs from the solid, chiefly in refusing to crystallise, and in containing an admixture of colouring and odoriferous substances, produced by the flowers from which the bee has extracted it."—*Johnston.*

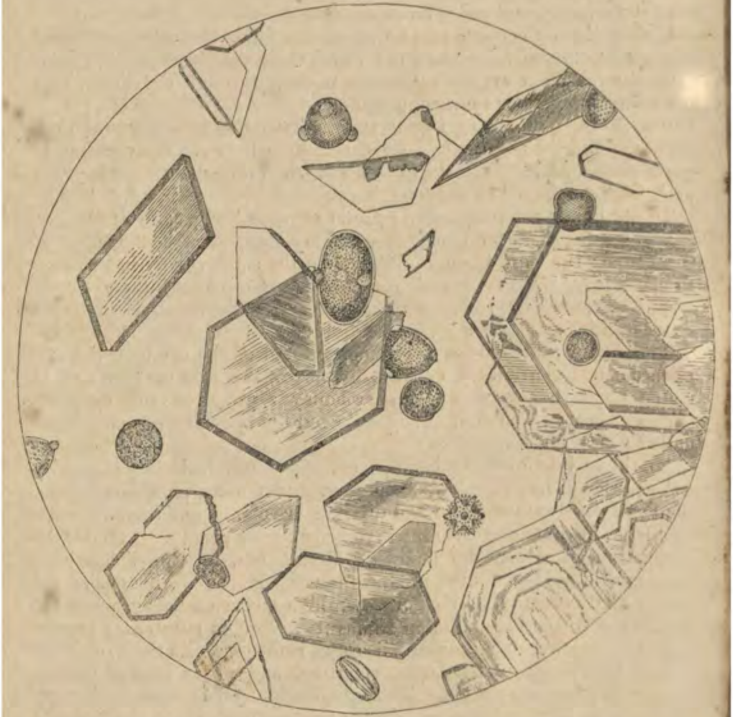
The honey which flows spontaneously out of the comb on the application of a gentle heat, consists entirely of the fluid portion, and is called *virgin* honey, while ordinary honey is procured both by pressure and heat. The first honey collected by bees is also sometimes called virgin honey.

To the various foreign substances contained in it, including especially pollen, the different colours, flavours, and odours possessed by the honey of different countries and districts are owing, and the possession of which, in some cases, causes it to be so highly prized. "Hence the estimation in which the honey of Mount Ida, in Crete, has been always held. Hence also the perfume of Narbonne honey, of the honey of Chamouny, and of our own high moorland honey, when the heather is in the bloom. Sometimes these foreign substances possess narcotic or other dangerous qualities, as is the case with the Trebizond honey, which causes headache, vomiting, and even a kind of intoxication, in those who eat it. This quality is derived from the flowers of a species of rhododendron, *Azalea pontica*, from which the honey is partly extracted. It was probably this kind of honey which poisoned the soldiers of Xenophon, as described by him in the Retreat of the Ten Thousand."—*Johnston.*

The solid part of honey, examined under the microscope, is seen to consist of myriads of regularly formed crystals; these crystals are for the most part exceedingly thin and transparent, very brittle, so that many of them are broken and imperfect; but when entire they consist of six-sided prisms. They appear to be identical in form with those of cane sugar, *fig.* 52. p. 184.

Intermingled with the crystals, may also be seen pollen granules of different forms, sizes, and structure; these are in such perfect condition, that in many cases they may be referred to the plants from which the honey has been procured. This is a very interesting and beautiful fact in relation to honey. The bees, in collecting the honey from the flowers, carry away with them also some of the pollen of those flowers; now this pollen consists of complex utricles or cells, differing in size, shape, and organisation in different orders of plants, and in different plants, so that the observer acquainted with the characters of the pollen of flowering plants, will be enabled in many cases to determine whether any particular honey submitted to his examination was collected from flowers of foreign or native growth, whether from those of the field, the garden, the heath, or the mountain.

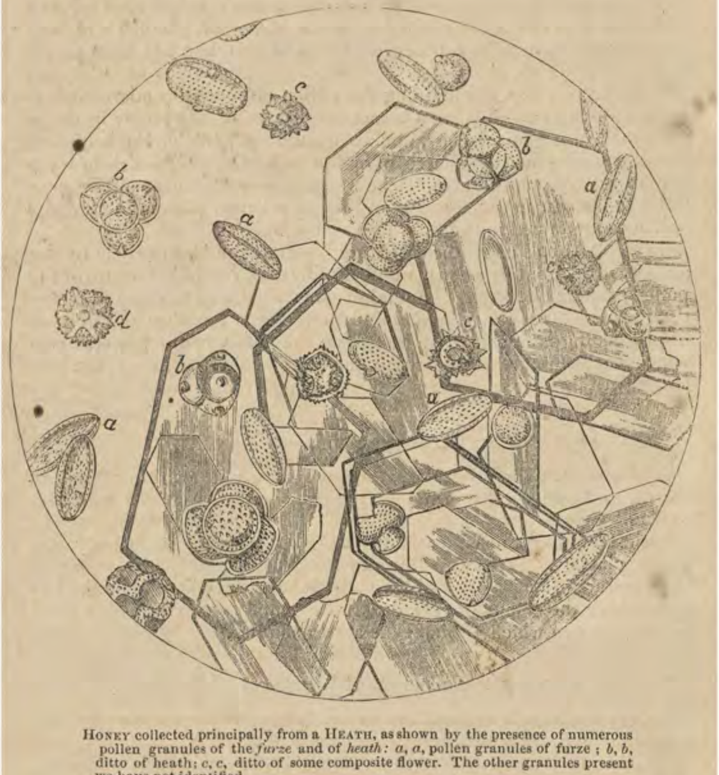
Fig. 61.



Crystals of HONEY, intermixed with the pollen granules of the flowers from which the Honey was gathered. Magnified 225 diameters.

It has occurred to the author, to make another highly interesting observation in connection with honey, showing, in a very striking manner, the amazing industry manifested by bees in the collection of honey. In examining the blossoms of our native heaths, some two or three years since, we were surprised to observe that there was scarcely one that had arrived at maturity that did not exhibit, usually on the upper surface of the corolla, one or more dark spots, occasioned by perforations. The conjecture at once occurred to us, that these perforations were made by the bees in their search for

Fig. 62.



HONEY collected principally from a HEATH, as shown by the presence of numerous pollen granules of the *furze* and of *heath*: *a*, *a*, pollen granules of furze; *b*, *b*, ditto of heath; *c*, *c*, ditto of some composite flower. The other granules present we have not identified.

honey, and in order to facilitate its abstraction from the tubular-shaped flowers. It was not long before the correctness of this conjecture was ascertained. The bees, on alighting on the flowers, almost constantly inserted their probosces either through one of the apertures already made, or they pierced a fresh one. Now of the countless myriads of blossoms in some miles of heath, there was scarcely one mature one observed by us, which had not been perforated.

A very good way of obtaining the pollen of honey for microscopical examination, is to dissolve a teaspoonful or so of the honey in water contained in a conical glass, and to examine a little of the sediment which subsides in the course of a few minutes, and which in some honeys is very considerable. The water causes the forms of the granules to change in some cases, and hence a better plan is to view the pollen as contained in the fluid part of the honey.

In the "Annals of Natural History" will be found an article by the author, illustrated by a large number of figures, on the structure of the pollen granule; this will be found of some assistance to those who may desire to identify the pollen found in honey. Another useful plan of proceeding is to collect and examine the honey of the flowers from which the bees are supposed to have collected the honey, and to search in this for the corresponding pollen granules.

THE ADULTERATIONS OF HONEY.

The more usual adulterations of honey are with various forms of *starch*, as those of the *potato* and *wheat*, and with *starch* and *cane sugars*.

Other adulterations mentioned by Mitchell and Normandy are chalk, plaster of Paris, and pipe clay.

The starch is not only added for the sake of weight and bulk, but to improve the colour of very dark honey, and to correct a sharp and acidulous taste which old honey is apt to acquire.

On the Detection of the Adulterations of Honey.

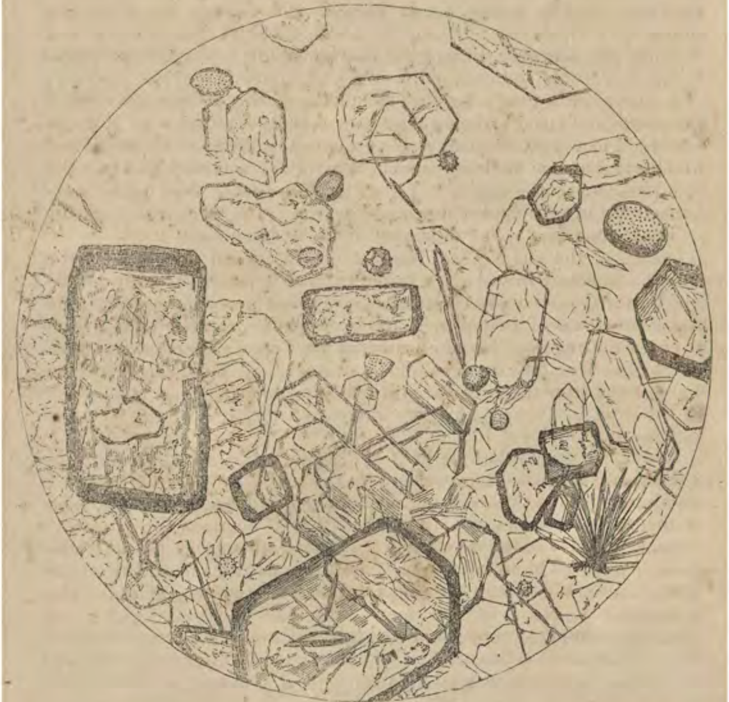
Of the adulterations practised upon honey, some are very easy of detection, and others difficult, if not impossible.

The general method of proceeding in the examination of honey, with a view to discover whether it is adulterated or not, is as follows: —

A little of the honey is to be examined under the microscope, when, if it contain unboiled starch, the granules will be visible, and may be identified by the characters which they present. If none are to be seen, a small quantity of tincture of iodine is to be added, which will show whether starch is present or not in any form.

The starch, as well as any insoluble and inorganic material which may be present, may also be discovered by dissolving a portion of the honey in warm water, when a deposit will occur after a time. This deposit should be examined, in the first instance, by the microscope;

Fig 63.



Honey adulterated with CANE SUGAR. The thick irregular crystals are those of cane sugar. Magnified 200 diameters.

and if it is not found to be of an organic nature, it most probably consists of chalk, or gypsum or sulphate of lime. If it effervesce it is no doubt chalk; and if not that substance, we must then proceed as described at p. 101. for the analysis of the last-named substance. For the quantitative determination of inorganic matters in honey, nothing more is requisite in ordinary cases than to collect, dry, and weigh the residues deposited from the solution of a given quantity of honey in water, or to take the weight of the ash.

The adulterations of honey, the discovery of which is more difficult, are those with cane and grape sugar.

Cane sugar becomes charred on the addition of sulphuric acid, and it is stated that grape sugar does not; this distinction, however, does not apply to honey, for it becomes charred equally with cane sugar.

There are, however, three ways in which the presence of *cane sugar* in honey may be determined, two of them being supplied by the microscope. The first is by the size and especially by the thickness of the crystals of sugar; their shape is essentially the same as those of honey. The crystals of cane sugar, as found in honey, differ from those of that substance in being much larger, thicker, and in their less regular shapes; the angles being acted upon by the fluid part of the honey, and in part melted down.

The second is, supposing brown sugar to have been used, by the presence of the sugar acari, discernible either on the surface of a solution of honey in water, or in the residue deposited from it.

The third method is chemical. Grape is separated from the cane sugar by means of Fehling's solution; the sugar which remains is of course cane sugar: it may be procured in a state of purity, by means of alcohol, from the residue left on evaporation. This method must be resorted to in those cases in which the cane sugar has been added in the state of syrup, and when in consequence its crystals are thus destroyed.

There are some other methods of discrimination : one of these is by the aid of the optical saccharometer of M. Biot.

Another is the process of M. Peligot. This consists in a saturation with sulphuric acid after the combination of sugar in the cold with lime, and which is repeated after the boiling of another portion of the same liquid. The difference between the quantities of acid necessary to saturation before and after boiling indicates the proportions of glucose.

A very simple process indicated by M. Payen in his work entitled "Des Substances Alimentaires," and employed in most sugar refineries in France, "consists in washing the rough or moist sugar with alcohol at 85°, lightly acidulated with five hundredths of acetic acid, and saturated with sugar-candy. The liquid dissolves the sugar of starch and the uncrystallisable sugar, while it does not attack the crystals of cane or beet sugar."

The adulteration of honey which, so far as we are aware, it is scarcely possible in many cases to detect, is that by *starch sugar*, since this possesses the same chemical properties as the sugar of honey. As glucose is usually made by boiling with sulphuric acid, and as the excess of this is sometimes neutralised with chalk, the presence of considerable quantities of sulphate of lime affords strong evidence of adulteration with sugar of starch.

MILK, AND ITS ADULTERATIONS.

If the testimony of ordinary observers, and even of many scientific writers, is to be credited, there are few articles of food more liable to adulteration, and this of the grossest description, than milk; but before proceeding to refer to the adulterations of milk, it will be proper to treat of its composition.

From the fact that persons may be entirely sustained upon a diet of milk for an indefinite period, it may be concluded that that fluid must contain all the elements necessary for the growth and sustenance of the human body, a view the correctness of which is fully established by chemical research.

Composition of Milk.

Milk consists of *water* holding in solution *casein* or *cheese*, *sugar of milk*, various *salts*, and in suspension, *fatty matter*, in the form of myriads of semi-opaque globules, to which the colour and opacity of milk is due.

Skim-milk, butter-milk, cream, butter, curds-and-whey, cream-cheese, and ordinary cheese, are mere modifications of milk, differing only from each other either in the abstraction of one or more of its constituents, or else in the variation of their proportions.

Skim-milk.—The first of these (skim-milk) differs from ordinary milk in containing a less quantity of fatty matter, a portion of this having been removed with the cream; it still, however, contains nearly all the cheese, the sugar of milk, some butter, and the salts of milk; it is therefore scarcely less nutritious than new milk, but, in consequence of the diminished amount of fatty matter, is less adapted to the development of fat, and to the maintenance of respiration and the temperature of the body. In some cases where fatty matter is found to disagree, and where, in consequence, milk in its usual state cannot be taken without inconvenience, skim-milk may be substituted with advantage.

Butter-milk.—Butter-milk approaches skim-milk in its composition, but contains a still smaller quantity of fat; as an article of diet for poor persons, it has the recommendation of cheapness.

Potatoes and butter-milk, as is well known, taken together, form a very considerable portion of the diet of the peasantry of Ireland: the butter-milk constitutes an essential part of such a diet, it supplying the nitrogenised matter necessary for the growth of the body, and of which the potatoes themselves are comparatively deficient.

Cream.—In contradistinction to these, cream consists almost entirely of the fat, with a very small quantity of the sugar, casein, and the other constituents of milk.

Butter.—Butter differs little from cream, but is more completely separated from the cheese, sugar, and salts; and the majority but not all the fat globules, in place of being free and distinct, have run together, so as to form a semi-solid substance.

Curds-and-Whey.—Curds-and-whey are made up of all the elements of milk, but the form in which they exist is altered; the cheese is thrown down by rennet, or by the addition of an acid, as acetic acid, and, in its descent, carries with it the greater part of the butter, the two together forming the curd; while the whey, or serum, consists entirely of water, the sugar, and the salts.

Cream-Cheese.—Cream-cheese consists of the moist curd (that is, of the cheese and butter), the greater part of the serum or whey being removed by slight pressure.

Ordinary Cheese.—Ordinary cheese contains little or much butter, according as it is made from skim or from whole milk: the casein is precipitated by rennet in the usual manner, and subjected to great pressure in moulds. *Annatto* is frequently added to heighten its colour, and the cheese is kept until it becomes more or less ripe.

The relative proportions of the different constituents of cow's milk, especially the fatty matter, are subject to very great variation: the age of the cow, the time after calving, food, temperature, weather, and the time and frequency of milking, all occasion considerable differences.

The constituents of cow's milk in the normal state, according to MM. O. Henrie and Chevalier, are as follows:—

Casein - - -	4·48
Butter - - -	3·13
Sugar of milk - -	4·77
Salts, various - -	0·60
Water - - -	87·02
	100·00

The following is the mean of ten analyses of pure milk by Professor Poggiale*:—

Water - - -	862·8
Butter - - -	43·8
Sugar of milk - -	52·7
Casein - - -	38·0
Salts - - - -	2·7
	1000·0

The *casein* of milk is an albuminous substance, distinguished from ordinary albumen by not coagulating when heated, by its coagulation by acetic acid, and also by the products of its spontaneous decomposition. The acids in excess form with it insoluble compounds, as do also various metallic salts as sulphate of copper, and bichloride of mercury.

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* Chemical Gazette.

The *butter* consists of a solid and liquid fats, in combination with glycerine. The proportion of this constituent of milk is very variable.

Sugar of milk is a crystallisable sugar; it is much less susceptible of fermentation than grape or cane sugar; it is very slightly soluble in alcohol, and is less soluble in water than cane sugar; it is also less sweet. Like grape sugar, it throws down the oxide of copper when its solution is boiled with sulphate of copper and liquor potassæ. By the action of nitric acid, it yields, like gum, saccholactic or mucic acid, so that it is intermediate in its properties between sugar and gum. This of all the constituents of milk is the least liable to vary in quantity.

Lactic acid is probably rather a product of the decomposition, than a normal constituent of milk.

Salts.—Of these some are soluble in alcohol as the lactates of potash,—the principal lactate,—of soda, ammonia, lime, and magnesia; others are soluble in water, but not in alcohol, as sulphate of potash, and the phosphates of potash and soda; lastly, the phosphates of lime, iron, and magnesia are insoluble in water.

For all practical purposes, in order to ascertain whether a milk is genuine and of good quality, it is sufficient to take the specific gravity of the milk by the hydrometer or galactometer, and to estimate the quantity of cream by the lactometer. Should we desire to institute a quantitative analysis of its chief constituents, we may then adopt the process described by Haidlen.*

The Butter.—The weighed quantity of milk is mixed with one-sixth of its weight of common unburnt gypsum, previously reduced to a very fine powder. The whole is then evaporated to dryness, with frequent stirring, at the heat of boiling water; a brittle mass is obtained, which is reduced to a fine powder. By digesting this powder in ether, the whole of the butter is dissolved out, and, after evaporation of the ether, may be obtained in a pure state, and weighed; or the powder itself, after being treated with ether, may be dried and weighed; the butter is then estimated by the loss.

The Sugar.—After the removal of the butter, weak alcohol is poured upon the powder, and digested with it. This takes up the sugar with a little saline matter, soluble in alcohol. By evaporating this solution, and weighing the dry residue, the quantity of sugar is determined; or, as before, the powder itself may be dried and weighed, and the sugar estimated by the loss. If we wish to estimate the small quantity of inorganic saline matter which has been taken up along with the sugar, it may be done by burning the latter in the air, and weighing the residue.†

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* Annalen der Chemie und Pharmacie, p. 263., copied in "Mitchell's Treatise," p. 78.

† M. Payen separates cane from milk sugar by means of ordinary brandy; the process will be found fully described at p. 102. of the work quoted at p. 204.

Saline Matter.—A second weighed portion of milk is now carefully evaporated to dryness, and again weighed. The loss shows the quantity of water. The dried milk is then burned in the air. The weight of the incombustible ash indicates the proportion of inorganic saline matter contained in the milk.

The Casein.—The weight of the butter, sugar, saline matter, and the water, being thus known, and added together, the deficiency shows the weight of the casein.

Other methods may be pursued.

Thus the casein and butter may be precipitated by acetic acid, the precipitate collected and dried, the water being got rid of by means of bibulous paper and afterwards by evaporation in a water-bath; it is then weighed; the fat is dissolved out by ether; the etherial solution is next evaporated in a weighed capsule with a gentle heat; the weight of the residual fat is then determined by the increased weight of the capsule. The difference between the weight of the dried curd and the butter gives the amount of casein.

The quantity of sugar may be estimated from the whey by the following process of Professor Poggiale:—

"The *test liquor* is prepared by adding to a solution of sulphate of copper, bitartrate of potash, and dissolving the precipitate which is formed in caustic potash. The strength of the alkaline solution is then determined with great care, from the quantity of sugar employed to decolourise a known volume of the liquid. It is important to observe that milk sugar, and not cane sugar, must be employed in this operation. I made several experiments, in order to avoid the determination of the strength of the solution of binoxide of copper, which is decidedly the longest and most delicate experiment. The following proportions constantly furnished a liquid, twenty cubic centimètres of which correspond to 0·200, or two decigrammes, of whey:—

	Grammes.
Crystallised sulphate of copper - - -	10
Crystallised bitartrate of potash - - -	10
Caustic potash - - - - -	30
Distilled water - - - - -	200

The filtered liquid is perfectly clear, and of an intense blue colour.

Preparation of the Whey.—"To determine the amount of sugar-of-milk, it is indispensable to separate the fatty matter and the casein by coagulation. This is easily effected by placing fifty or sixty grammes of the milk in a small flask, adding to it a few drops of acetic acid, and then raising the temperature to between 104° and 122°. A transparent liquid is obtained on filtration. According to my experiments, 1000 grammes of milk yield 923 grammes of whey, which gives for 1000 grammes of whey about fifty-seven grammes of sugar.

Examination of the Whey.—"Twenty cubic centimètres of the test liquor are introduced by means of a pipette into a small flask, which should be preferred to a porcelain capsule, as it allows of the liquid being seen from top to bottom, and of observing with the greatest ease the moment the decolourisation is complete. The liquid is then boiled. On the other hand a burette, each division of which is equal to a fifth of a cubic centimètre, is filled with the whey and poured drop by drop into the liquid, agitating the latter continually, and heating it after each addition of whey. This is continued until the blue tint has entirely disappeared. At first, a yellow precipitate of hydrated protoxide of copper is formed, which, however, soon turns red, and sinks to the bottom of the flask. When the operation is terminated, the quantity of whey employed is read off the burette, and the weight of sugar contained in 1000 grammes of whey determined by the rule of three."—*Poggiale.*

"Milk sugar reduces a much smaller proportion of oxide of copper than grape sugar; for whilst 1 gramme* of the latter decomposes 6·926 of sulphate of copper, 1 part of milk sugar reduces, according to *Neubauer*, 4·331, according to *Mathaim* 4·158, parts of oxide of copper." — *Fresenius.*

A very close approximation to the quantity of sugar present in milk, may be obtained by simply evaporating the whey to dryness, weighing the residue, and deducting the weight of the ash left in its incineration.

Specific Gravity of Milk.

As the composition of milk varies, so of course does its specific gravity.

Genuine cow's milk has an average specific gravity of about 1030; it seldom exceeds 1031, but is frequently several degrees lower. The great variation in the specific gravity of milk is occasioned by corresponding variations in the quantity of butter or cream present; the butter of milk being so much lighter than water, the greater the proportion of butter, the lighter of course is the milk.

That this is really so, is shown by the following table.

TABLE SHOWING THE VARIATION IN THE SPECIFIC GRAVITY OF GENUINE MILK, AND THE RELATION OF THIS TO THE PER-CENTAGES OF CREAM.

Cows.	Milk. Spec. Grav.	Skim. Spec. Grav.	Cream.
1	1031	—	2°
2	1029	—	2½
3	1019	1027	26
4	1008	1026	80
5	1030	—	2½

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* Fresenius recommends that the whey be cleared with a little white of egg and filtered, and the filtrate diluted with nine times its volume of water.

Cows.	Milk. Spec. Grav.	Skim. Spec. Grav.	Cream.
6	1027	1030	9
7	1026	1028	13
8	1029	1030	8
9	1030	1031	7
10	1024	1028	10
11	1027	1031	10
12	1023	1030	25
13	1024	1031	32
14	1025	1029	10

The above table includes samples of both morning and afternoon milks, as well as some of the first and last milk obtained at the same milking; they are not, therefore, to be taken as average samples of milk.

From an examination of the table, it appears that a milk may be of high specific gravity, and yet yield but little cream (see 1); or it may be of low specific gravity, and yet afford a very large quantity of cream (see 4); also, that the removal of the cream increases the density of the milk (skim-milk) several degrees. It will be observed that not one of the samples in the table shows a low specific gravity with deficiency of cream. We have never met with a natural milk of this kind, and believe it to be of very rare occurrence.

The specific gravity of the *serum* of milk is due mainly to the sugar contained in it; and as this constituent is the least variable, so is its specific gravity the least subject to variation,—a circumstance of considerable importance, as will be shown presently.

TABLE SHOWING THE DENSITY OF SERUM, AND ITS RELATION TO THE SPECIFIC GRAVITY OF MILK.

Cows.	Milk. Specific Gravity.	Serum. Specific Gravity.	Cows.	Milk. Specific Gravity.	Serum. Specific Gravity.
1	1029	1028	22	1022	1027
2	1026	1028	23	1030	1027
3	1029	1025	24	1031	1028
4	1031	1027	25	1028	1028
5	1030	1027	26	1030	1028
6	1008	1025	27	1031	1028
7	1019	1027	28	1028	1027
8	1026	1026	29	1028	1027
9	1030	1027	30	1027	1028
10	1028	1028	31	1028	1027
11	1027	1027	32	1030	1028
12	1026	1027	33	1029	1028
13	1027	1025	34	1026	1027
14	1029	1027	35	1024	1026
15	1030	1027	36	1027	1026
16	1030	1027	37	1026	1028
17	1023	1028	38	1028	1028
18	1023	1028	39	1026	1027
19	1025	1027	40	1026	1026
20	1024	1027	41	1030	1026
21	1024	1028	42	1023	1028

The above table includes many samples of milk of an exceptional character.

It will be observed, that while the specific gravity of the milk extends over a wide range, varying from 1008 to 1031, that of the serum, on the contrary, is subject only to a slight variation, the limits being from 1028 to 1025.

We have here, then, a fixed datum, from which to determine, with precision, the adulteration of milk with water, a point of the greatest importance.

The specific gravity of *skim-milk*, although not so fixed as that of the serum, is yet much more so than that of whole milk: its average weight is estimated by Pereira at 1·034·8.

Variations in Composition of Milk.

It has been stated that the composition of milk is subject to very great variation according to several modifying circumstances: the chief of these are, the age of the cow, its condition, the time and frequency of milking, the nature of the food, housing of the cows, and temperature.—We shall bestow a few remarks on each of these causes of variation.

Influence of Age on Milk.—With respect to age, a young cow with her first calf gives less milk than with her second, third, or fourth calf, she being considered to be in her best condition, in most cases, when from four to seven years old.

The period during which cows give milk after calving is usually five or six months, but very frequently the time is much prolonged beyond this; we have been informed of an instance of a cow continuing to give milk for three years and a half after calving.

Influence of Condition on Milk.—The first milk yielded by the cow after calving is yellow, thick, and stringy: it is called colostrum, and by milkmen and others, "beastings." This state of the milk lasts from about three weeks to a month, but is very bad for the first ten days, during which time the milk is not fit for use. From the end of the first to the termination of the third or fourth month, the milk is in its best condition.

The cow carries her calf for forty weeks, or ten lunar months: it is the common practice to milk the cow regularly for the first seven, eight, or nine months of this period, a practice which, at first sight, appears to be highly objectionable, but which is really not so much so as might be supposed; and it is rendered absolutely necessary by the fact that cows could not otherwise be profitably kept; nevertheless, it is very important that the milking should not be continued too long, for the sake of the cow, the calf, and the milk itself: in general it should cease at the end of the seventh month; many cowkeepers, however, continue to milk up to a very short period of calving.

Another very objectionable practice is to permit the cow again to become in calf within two or three months after having calved; the object of doing so is to derive as much profit as practicable from the animal, without regard to the effect on its constitution, the quality of the milk, or the growth of the calf. It is impossible to conceive that a cow can continue to yield large quantities of good milk daily, and afford, at the same time, sufficient nourishment for carrying on effectively the process of gestation.

Influence of Food on Milk.—The natural food of the cow is evidently that derived from pastures, viz. grass, the milk obtained from cows fed upon this being of excellent quality and sufficiently rich for all purposes.

The next most natural food is dried grass or hay, which is given largely to cows in winter, the milk being nearly the same in quality as from grass.

Beet root and carrots, being very nutritious, are also usually given to cows in the winter time with advantage. With regard to the effect of beet root and carrots on milk, we obtain the following information by MM. O. Henrie and Chevalier, as reported in Mr. Mitchell's treatise on the "Falsification of Food," p. 74.

The constituents of cow's milk in the normal state, according to MM. O. Henrie and Chevalier, are as follow:—

Casein (cheesy matter)	4·48
Butter	3·13
Sugar of milk	4·77
Salts, various	0·60
Water	87·02
	100·00

When the cows are fed on beet:—

Casein	3·75
Butter	2·75
Sugar of milk	5·95
Salts	0·68
Water	86·87
	100·00

When on carrots:—

Casein	4·20
Butter	3·08
Sugar of milk	5·30
Salts	0·75
Water	86·67
	100·00

It will be observed that, according to the above tables, the effect of feeding cows on carrots is to occasion a slight diminution in the amount of casein and butter, but an increase in the quantity of sugar, while feeding them on beet root reduces still more the quantity of casein and butter, but very largely increases the sugar,—effects which, from the richness of carrot and beet in sugar, might have been anticipated.

As is well known, a very considerable number of the cows which supply London with milk, are kept in various confined and unhealthy places in the metropolis; such cows are seldom turned out to grass; the system of feeding adopted being altogether artificial and unnatural, brewers' grains and distillers' wash forming the chief part of their food; these stimulate the animals unnaturally, and under the stimulus large quantities of milk of inferior quality are secreted, the cow quickly becoming worn out and diseased in consequence.

In reference to the effects of grains on cows, Mr. Harley makes the following remarks:—

"Brewers' and distillers' grains, and distillers' wash, make the cattle grain-sick, as it is termed, and prove injurious to the stomach of the animal. It has been ascertained that if cows are fed upon these grains, &c., their constitutions become quickly destroyed."*

MM. Boussingault and Lebel, from experiments made, have arrived at the conclusion that the kind of food has not a great influence either upon the amount or composition of milk, provided quantities containing equal proportions of nutritious matter be given.

Influence of Temperature on Milk.—In hot countries and dry seasons the quantity of milk yielded is said to be less, but the quality is richer; it is also stated that cold favours the production of sugar and cheese, whilst hot weather augments the amount of butter.

It would be extremely desirable to ascertain precisely the extent to which the quality of milk is influenced by weather.

Influence of the Time and Frequency of Milking.—With regard to the quality of milk as affected by the time and frequency of milking, morning milk is said to be better than that obtained in the afternoon; and the milk of cows when milked but once a day, is richer than either. It is the common belief that the last portion of the milk obtained at any milking is richer than the first; we have taken pains to ascertain whether there is any foundation for such an opinion, and find it to be really the case to a remarkable extent, as will appear from the following table.

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* Harleian Dairy System, pp. 73. and 74.

Table showing the Difference in the Quality of the First and Last Milk obtained at each Milking.

1st Milk.

Afternoon.

Cows.	Milk. Spec. Grav.	Cream.
1	1027	9°
2	1026	13
3	1027	8
4	1029	7
5	1030	11
6	1030	8
7	1029	3½
8	1031	2
		61½

2nd Milk.

Cows.	Milk. Spec. Grav.	Cream.
1	1033	25
2	1023	22
3	1025	10
4	1024	15
5	1024	32
6	1022	25
7	1026	7½
8	1030	5
		141½

From an examination of these tables it appears that the second milks are of much lower specific gravity than the first; and hence, had the specific-gravity test alone been relied on, they would have been pronounced to be inferior in richness to the first; a conclusion the reverse of that which is correct. Thus, while the cream of the whole eight samples of the first milks amounted to 61½ per-centages, that of the last amounted to 141½; that is, they contained more than double the quantity of cream. This fact is not without practical importance.

It is a common practice for invalids and others to procure their glass of milk direct from the cow; we thus perceive that in this way they seldom obtain the proper proportion of butter, a circumstance which may be of advantage in some cases, and of disadvantage in others. In London it is now common for cows to be driven through the streets, and to be milked in the presence of the purchasers: although in this way the buyer succeeds in procuring it genuine, he does not always obtain the best milk.

The great difference in the amount of cream contained in the first and last milk taken from the cow at one milking, appears to be satisfactorily explained on the supposition that the fatty matter of the milk obeys the same laws of gravity in the udder of the cow that it does when set aside in an open vessel.

The following tables show the varieties in the specific gravity of milk, and the per-centages of cream in morning and afternoon milk.

TABLE SHOWING THE SPECIFIC GRAVITY OF PURE MILK, AND THE PER-CENTAGES OF CREAM.

Morning Milk.

Cows. Richmond.	Milk. Spec. Gravity.	Cream.	Curd.
1	1030	6½	63 grs.
2	1031	7	69 „
3	1028	4½	66 „
4	1030	9	80 „
5	1031	10	78 „
6	1028	7½	75 „
London.			
7	1030	12	55 „
8	1023	5	81 „
9	1029	7	61 „
10	1028	9	65 „
Average nearly	1029	Total - 77½	Total - 693 „

Average about 7½.

Afternoon Milk.

Cows. Richmond.	Milk. Spec. Gravity.	Cream.	Curd.
1	1028	7½	69 grs.
2	1027	10	91 „
3	1027	6	75 „
4	1028	9	78 „
5	1028	11½	87 „
6	1027	7½	83 „
London.			
*7	1028	22	98 „
*8	1026	6	74 „
*9	1026	6	69 „
*10	1026	11	86 „
Average about	1027	Total - 96½	Total - 810 „

Average more than 9½.

The Richmond cows from which the first six morning and afternoon milks were obtained, were fed partly on grass and partly on grains

It is desirable that the following particulars relating to each cow should be made known:—

Cows.	Age.	Number of Calves.	Date of last Calf.	Yield per Diem.
1	5½ years	3	5 weeks	14 quarts
2	7 "	4	7 months	7 "
3	7 "	4	5 "	10 "
4	8 "	5	6 "	16 "
5	5 "	3	7 "	8 "
6	10 "	7	5 "	12 "
*7	6 "	2	10 weeks	10 "
*8	6 "	3	3 "	10 "
*9	5 "	2	3 months	10 "
*10	7 "	3	9 weeks	9 "

The samples were taken from the milk-pail containing the whole of the milk obtained from each cow, and whilst still warm.

From the preceding tables, it appears—

1st. That the *specific gravity* of genuine milk, in its ordinary condition, varies between 1031 and 1026; and that the average specific gravity of the morning milk is about 1029, and the afternoon 1027.

2nd. That the amount of *cream* ranges from 4½° to 22°, the average being 9½°.

3rd. That the quantity of *curd* varies from 55 to 98, the average being 75.

The above are the results in the case of samples of milk of ordinary quality; but exceptional cases sometimes occur, in which the specific gravity is less, as also the quantity of cream, curd, butter, and cheese.

On the Housing of Cows.—In a very useful little pamphlet, published some time since by Mr. H. Rugg, surgeon, on London Milk*, we meet with many particulars relating to the improper mode pursued in feeding and housing cows kept in various parts of the metropolis.

"Any place, any hovel," writes Mr. Rugg, "cow-keepers seem to consider, will do for a cow,—narrow lanes, confined corners, &c.,—and yet they wonder how it is, that they lose so many from disease. Can any one with a grain of common sense at all wonder that cows should be afflicted with disease when they are huddled together in a space that does not allow them sufficient breathing-room, with their heads placed close up to the wall, and without a sufficient current of air or ventilation? The carbonic acid expired from their lungs is, before it can rise, the greater part inhaled again, unmixed with a sufficiency of pure air, so necessary for the oxidation of the blood, and consequent vitality of the body.

"The air of the cow-houses is not alone vitiated by the exhalations from the lungs of the cows, but from the improper drainage of their sheds, and from the collections of all kinds of offal and filth and vegetable substances in a state of decomposition, together with pigs running about the place, or enclosed in one corner of the shed."

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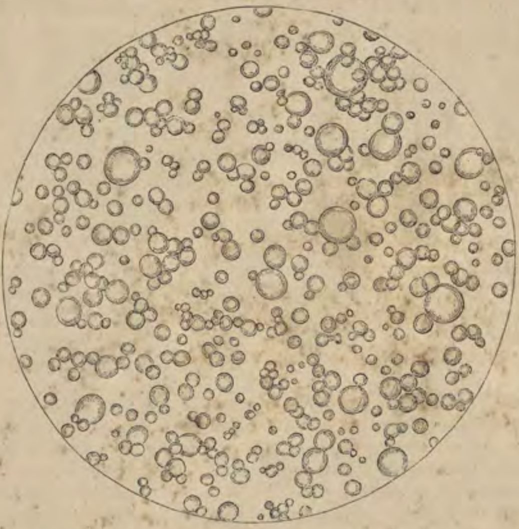
* Observations on London Milk, second edition. 1*s*. Bailey and Moon, Regent Street.

Other observations on the same subject will be found recorded in the Harleian Dairy System, p. 14.; Aiton's Dairy Husbandry, p. 70.; and in a Pamphlet on the Sanitary Condition of the Parish of St. James's, Westminster, by the Hon. F. Byng.

Fig. 64.
GOOD MILK.



This and the five following figures are all drawn to a scale of about 630 diameters.

The necessity for an abundance of pure air is shown by the following calculation:—Dr. Thomson* states that one cow, consuming 6 lbs. of carbon in its daily food, for respiratory purposes, would require 956¼ cubic feet of atmospheric air.

On the Characteristics of Good Milk.

Good milk is a white homogeneous fluid, of sweet and bland taste, not becoming viscid on the addition of ammonia. It should have a specific gravity of about 1030, and should yield about 9½ percentages, by the lactometer, of cream.

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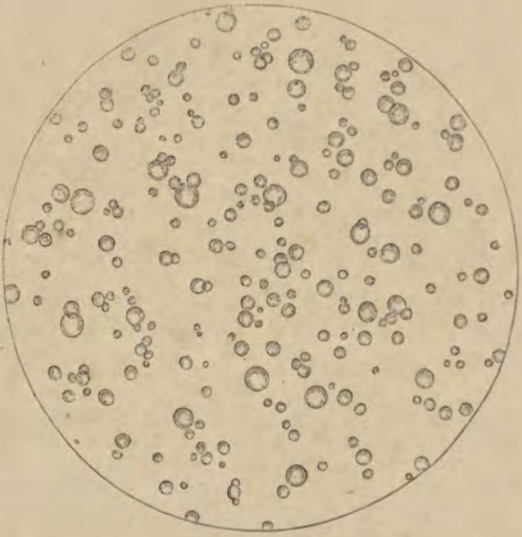
* Experimental Researches on the Food of Animals, p. 114.

The specific gravity of genuine whole milk is liable to vary, ordinarily, however, within the limits of 1026 and 1031; that of the serum from 1025 to 1028; the cream is likewise subject to very great variation.

Fig. 65.

POOR MILK.



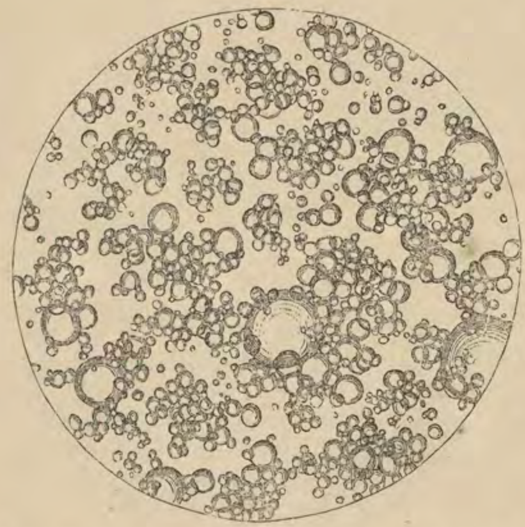
Examined with the microscope, it is found to contain myriads of beautifully formed globules of fatty matter of various size, and reflecting the light strongly, and which globules are entirely and readily soluble in caustic potash: in fact, good milk under the microscope presents the appearance exhibited in *fig*. 64.

If the milk exhibit any want of complete homogeneousness or is of imperfect liquidity; if it be viscid, or become so on the addition of ammonia; if, examined with the microscope, blood, or pus, or colostrum corpuscles are present, the milk is not healthy milk of good quality; lastly, if the fat globules are comparatively few, and of small size, the milk is poor.

Cream consists almost entirely of these fat globules, some of which are often met with of very considerable size.

The curd of milk, as already explained, is composed of both the cheese and the fat globules. Its appearance under the microscope is represented in *fig.* 67.; the casein or cheese is distinguished by its granular texture.

Fig. 66.
CREAM.



The first milk yielded by the cow after calving, called colostrum, is characterised, as before noticed, by the presence of numerous corpuscles of large size and granular appearance. Cow's milk in the state of colostrum is represented in *fig.* 68.

On the Apparatus employed to determine the Purity and Quality of Milk.

Independent of a quantitative chemical analysis, the purity and quality of milk are often judged of by its specific gravity and the quantity of fatty matter or cream which the milk furnishes.

The *specific gravity* or weight of milk may be determined by means of the ordinary specific-gravity bottle; it is more frequently ascertained by means of the common hydrometer, or by the galactometer, of which several varieties have been devised.

The best of the galactometers is the instrument invented by M. Dinocourt*, named the *Centesimal Galactometer*.

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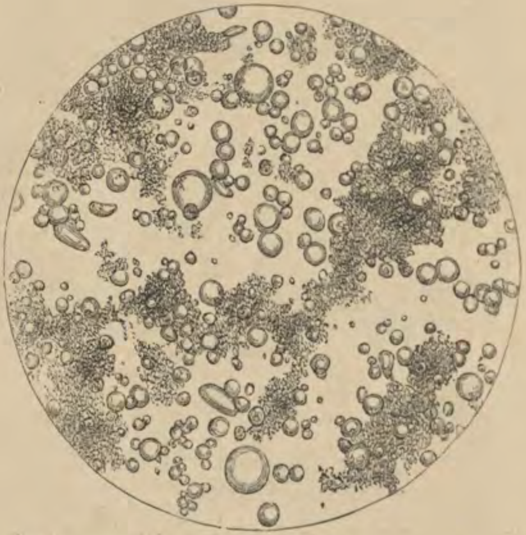
* Constructeur d'instruments de physique, et de chemie en verre, 9. Quai St. Michel à Paris.

"The centesimal galactometer is represented in *fig*. 70.; it is composed—

"1st. Of a stem *A*, *a*, enclosing scales.

Fig. 67.

Curd of Milk.



"2nd. Of a cylinder *B*, serving to float it.

"3rd. And of a bulb *C*, charged with shot, serving as a ballast, so that the instrument floats upright in the milk. Of these three parts, it is only necessary to well understand one, that which encloses the scales *A a*; the scale *A*, *in part coloured yellow*, serves to weigh the milk with its cream; the first degree on the top of the scale is marked 50. The following extend from 50 to 100 and over.* Each degree starting from 100 in mounting up to 50 represents a hundredth of pure milk: the degrees formed by a line are equal, as 50, 52, 54, &c.; the degrees formed by a dot are unequal degrees, as 81, 83, 85, &c. To comprehend well the value of the degrees of this scale, it is sufficient to give an example:—Supposing then that the galactometer is sunk to the 85th degree, that will indicate 85-hundredths of pure milk, and consequently that 15-hundredths of water had been added to this milk; the galactometer is stopped at 60 degrees, there will be 40-hundredths of water, or four-tenths of water added. We see from this that in adding to the number of hundredths indicated by the instrument a complementary number to form one hundred, this complementary number will give in hundredths the quantity of water added to the milk under trial. If we wish to avoid reckoning by hundredths, one may count only by tenths; we have only to notice that the first tenth is white, that the second is coloured yellow, the third is white, the fourth yellow, and that the fifth is also white. This alternation of white and yellow gives a very evident demarcation between each tenth; towards the middle of each tenth we have placed the figures 1, 2, 3, 4, 5, to indicate their order.

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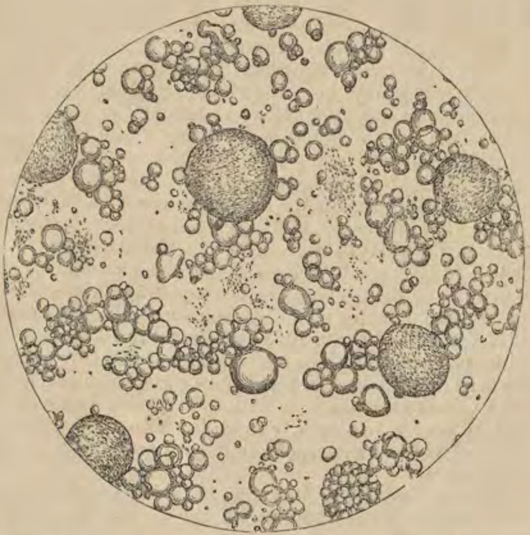
* It will be seen that this scale has been cut down to half its graduation, and that its 0 corresponds to distilled water; we have suppressed the first 50 degrees, which would have lengthened the stem of the instrument, and have rendered it more fragile without any utility.

Fig. 68.

COLOSTRUM.



"The space comprised between 100 to 120 is also coloured yellow; this comprehends the different densities of pure milk—that is to say, without the extraction of cream, as well as without the addition of water; we have prolonged the scale from 120 to 136, so that it may serve in all cases.

"The scale *a*, in part coloured blue, is destined to weigh skim-milk; it is, like the first, divided into 100 degrees or hundredths, of which the first 50 have been cut off as useless; each degree commencing from

100 to 50, and mounting upwards represents a hundredth of pure skimmed milk; consequently, the manner of estimating the quantity of water added to skim-milk is absolutely the same as for pure milk with its cream; the examples given for estimating the value of pure milk are applicable to skim-milk. We may equally confine ourselves to estimating the value by tenths; these tenths, alternately coloured blue and white, are sufficiently distinct not to be confounded.

"These two scales give the value of milk only in hundredths; nevertheless, it will always be easy to compare these degrees with the density *or specific gravity of milk;* we understand by the word *density* the specific weight of any liquid, water being taken as a thousand, a litre of distilled water weighing 1000 grammes or one kilogramme, at the temperature of 4° of the centigrade thermometer.

"If now we wish to know the density of the milk under trial, we call to mind that 50 degrees of the scale *A* of the galactometer corresponds exactly with 1014 degrees of the densimeter of M. Collardeau*, and that each tenth of the scale of the galactometer is equal to three degrees of the densimeter; consequently, three-tenths and a third are equal to a degree of this densimeter: thus, 1014 correspond to 50, 1017 correspond to 60, 1020 correspond to 70, &c."

It will be perceived that this instrument is essentially a densimeter or measurer of specific gravity; and since the specific gravity of milk is subject to great variation from natural and other causes, the galactometer is of course, to a great extent, liable to the same fallacies as the densimeter or hydrometer, although both are capable of affording useful indications.

Pure milk not deprived of its cream has a less specific density than skim-milk caused by the lightness of the cream. If the cream be either in part or wholly removed from milk, the residual milk will weigh heavier than that which contains its normal proportion of cream. Skim-milk, therefore, tried by the galactometer scale, for pure milk only, would give a higher specific gravity than ordinarily belongs to pure milk, and hence the error might be committed of supposing it to be pure, an error which can only bé corrected by means of the lactometer, by estimating with it the per-centage of cream; should this per-centage fall short of that which is proper to pure milk, the sample of milk is one the value of which should be determined by the scale for pure skim-milk.

Again, if to such skim-milk we add a certain per-centage of water, we restore to it its proper specific gravity, and therefore this milk would show, with the centesimal galactometer, the density proper to pure milk, and hence this fraud would escape detection. In order to meet cases of this kind, which are of frequent occurrence — namely, the complete or partial removal of the cream, it is recommended, and indeed necessary, to employ the lactometer, and ascertain by it whether the sample under examination contains the proper proportion of cream or not; indeed it is scarcely possible in any case to come to certain or safe conclusions without employing the lactometer.

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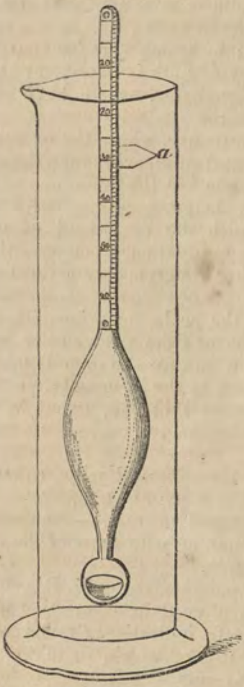
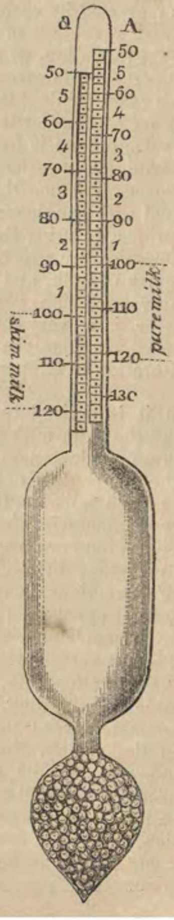
* *a* 15 centigrade.

Fig. 69.
COMMON HYDROMETER.
(*Reduced one-half.*)


10
20
30
40
50
60
a

a, Range of pure milk.

Fig. 70.
THE CENTESIMAL GALACTOMETER.
(*On a reduced scale.*)


a
A
50
5
60
4
70
3
80
2
90
1
100
110
120
skim milk
50
5
60
4
70
3
80
2
90
1
100
110
120
130
pure milk

Where the specific gravity of a milk is very light, and this not produced by a large excess of cream, it is due to the admixture of water, the quantity of which may be determined with considerable accuracy by the common hydrometer, but still more accurately by the centesimal galactometer.

The reason for having two scales, one for pure and the other for skim-milk, it will be perceived, is on account of the very different densities possessed by each.

The great advantage of the centesimal galactometer consists in its centesimal graduation, whereby calculation is so much facilitated, and in the wide range of degrees which it affords; thus while in the hydrometer the range of degrees from pure milk to milk adulterated with fifty per cent. of water is only from 1016° to 1031°, that in the centesimal galactometer is from 50° to 100°; by which arrangement far greater accuracy in estimating the density of milk is obtained; thus, three degrees and one-third of the galactometer, as we have seen, correspond with one degree of the densimeter.

It is proper, in using the ordinary hydrometer, where the extremes of temperature are great, as in winter and summer, to take the specific gravity of milk, and to make allowance for the difference which temperature occasions; this precaution being necessary with the hydrometer, it is very much more so with the centesimal galactometer, in which, from the delicacy of the graduation, a comparatively slight alteration of temperature occasions a difference of several degrees.

When it is desired to make use of the scale for skim-milk, one portion of the skim-milk is to be set aside for from twelve to twenty-four hours in a lactometer; another in a pan for the same length of time: the per-centage of cream to be noted in the lactometer, and the density of the milk in the pan, after being skimmed, taken in the ordinary manner with the centesimal galactometer, corrections being made for the temperature.

The pamphlet of M. Dinocourt is accompanied with coloured tables of corrections, in which allowance is made for temperature,— that is, the apparent degrees are reduced to real,—the degrees of the hydrometer or densimeter corresponding with those of the centesimal galactometer are shown side by side.

Considered altogether, the centesimal galactometer of M. Dinocourt is capable of affording, especially when used in connection with the lactometer, very useful and accurate indications; much more so than the ordinary hydrometer, the use of which, in taking the specific gravity of milk, ought entirely to supersede it.

Its construction will be comprehended from *fig*. 70.

Of all the constituents of milk the sugar is the least subject to variation, and as the density of the serum of milk is principally due to the sugar, its specific gravity of course is also but little liable to alteration. This statement is founded upon the results of numerous observations. It therefore long since occurred to us, that the utility of the galactometer might be greatly enhanced by the addition of a centesimal scale for the serum of milk. The advantage of this scale would be that—starting from a fixed point, the normal specific gravity of the serum—it would show, with very great nicety, the extent of the more usual adulteration of milk, namely, that with water; for in proportion as water is added, so does the weight of the serum diminish, and this in such a marked manner that the quantity of water added may readily be determined in per-centages. Numerous observations are first required, in order to fix accurately the normal specific gravity of the serum of the milk of the cow.

Method of determining the Cream. — The amount of cream is determined by means of an instrument invented by the late Sir Joseph Banks, termed a *lactometer*. This consists of a tube, usually eleven inches long and half an inch in diameter; ten inches of this are graduated in tenths of an inch — that is, in hundredths of the whole. The tube is filled with milk, and set aside for twelve hours; the cream ascends to the surface, and its amount is determined by the thickness of the stratum formed, and which is ascertained by noting the number of degrees or tenths through which it extends.

Some lactometers resemble test tubes in shape, and, like them, are supported in racks; they are usually graduated only in the upper two inches; others are provided with feet, and are graduated throughout their whole length. As the quantity of cream not unfrequently exceeds twenty and has even been known to reach eighty per cent., the tubes should in all cases be graduated for nearly their whole length.

The construction of the lactometer is shown in the accompanying woodcut, representing a rack, holding four of these instruments.

Cream forms more quickly in warm than cold weather; and in making comparative observations on a number of samples, it is proper that each should be set aside in lactometers, at the same time and for the same period.

The thickness of the stratum of cream formed on genuine milk is, like the specific gravity, subject to considerable variation: in two extreme cases we have met with, one of the samples showed but *two* degrees of cream, and the other *eighty*. According to Dr. Normandy, the thickness of the stratum of cream on pure milk is generally from 8 to 8½ per-centages: M. Dinocourt finds the per-centages to range between 9 and 14, while, according to our observations, the *average* does not exceed 9½.

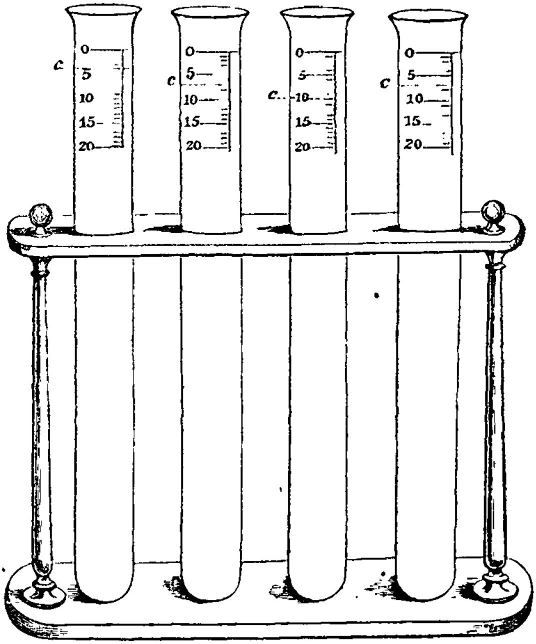
It must be remembered that London milk, as delivered to houses, consists in general of the milk of different cows mixed together; and therefore, in order to determine what ought to be the depth of cream formed on good milk, we should take the average amount obtained from such mixed milks.

We have said that the quantity of cream varies much in different samples of genuine milk; and not only is this the case, but it should also be known that the amount of cream yielded by any sample of milk is no certain criterion by which to judge of its quality, as

Fig. 71.

LACTOMETER AND STAND.

(*On a reduced scale.*)



The dotted lines indicate the per-centages of cream on four samples of milk from different cows after standing twelve hours.

some milks are rich in cream and deficient in casein and sugar, and *vice versâ.*

It is stated that the addition of a small quantity of warm water to milk increases the amount of cream; the belief in the accuracy of this statement is general, and it is commonly acted upon by milkmen; nevertheless, the assertion is entirely erroneous — the addition of water to milk does not increase the quantity of cream; it merely facilitates and hastens, in a most remarkable manner, its formation and separation, as is shown by what follows: —

Six lactometers were filled, one with pure milk, the remainder with the same milk diluted respectively with ten, twenty, thirty, forty, and fifty per-centages of water.

Twenty minutes after the addition of the water, the lactometer showed, in the milk containing fifty per cent. of water, six degrees of cream; in that with forty per cent., five degrees; with thirty per cent., four degrees; with twenty per cent., three degrees; with ten per cent., one degree; and in the pure milk, half a degree only.

At the end of forty minutes, the cream stood thus: six and a half degrees on the milk containing fifty per cent. of water; six on that with forty per cent.; five and a half on that with thirty per cent.; five on that with twenty per cent.; four and a half on that with ten per cent.; and four on the pure milk.

At the end of twelve hours, the milk with fifty per cent. of water showed five degrees of cream; that with forty per cent., five degrees and three quarters; that with thirty per cent., six and a half degrees; that with twenty per cent., seven degrees and a quarter; that with ten per cent., eight degrees; and the pure milk, nine degrees of cream.

It thus appears, that the addition of a large quantity of water to milk occasions an almost immediate formation of cream, but does not augment the amount; of this fact, in some cases, it would be an advantage to dairymen to avail themselves. The addition of water to milk of course lessens its specific gravity, and so facilitates the ascension of the cream.

The Lactoscope.—Some years since an instrument termed a lactoscope was invented by M. Donné, of Paris, for determining the richness of milk, by estimating the quantity of butter contained in it.

We have procured one of these instruments, accompanied with a description, and directions for its application; from these we extract the following observations:—

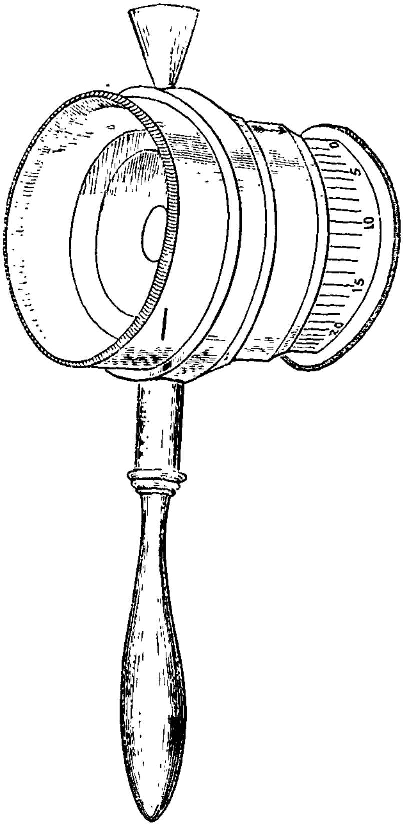
"Milk owes its white dense colour to the globules of fatty matter or butter which it contains; the more numerous these globules the more opaque is the milk, and the more, at the same time, is it rich in the fatty part or in cream, the more or less opacity being in relation with its principal quality—its richness in cream; the measure of this opacity is capable of giving then, indirectly, the measure of the richness of the fluid, and of indicating its value.

"But the degree of opacity of milk cannot be appreciated upon a mass of the fluid; it is not possible to measure it but in very thin layers, and it is this which is done with our lactoscope. This instrument is constructed in such a way that the milk may be examined in it in layers of every thickness, from the thinnest, through which all objects may be distinguished, up to that which allows of nothing to be perceived; it gives at once the richness of milk in indicating the degree of opacity to which the proportion of cream stands in relation.

"The instrument consists of a kind of eye-glass, composed of two tubes sliding one within the other, furnished with two parallel glasses, which approach each other up to contact, and separate more or less

Fig. 72.

The Lactoscope.



the one from the other at will by means of a very fine screw; a little funnel destined to receive the milk is placed at the upper part; on the opposite side is fixed a handle, which serves to hold the instrument. The tube which screws within the other forms the anterior or ocular part, that to which the eye is applied; it is marked with divisions to the number of 50, and figures which indicate the richness of the milk.

"A few drops of the milk to be examined are poured into the funnel. It is necessary to take the sample of milk from the mass of the milk, and not the surface of the liquid only, where the layer of cream collects; if then the milk has been at rest for some time, it must be agitated a little in order to mix all the parts.

"The funnel being full, the ocular tube is turned from right to left until the liquid has penetrated between the plates of glass, and collected at the bottom; the ocular tube is then turned in the contrary direction, from left to right, and one looks through it until the flame of a taper or candle can be distinguished. At this point stop and impress a slight rotatory movement, until, by a little manipulation, the light is lost to view, without going beyond the moment when it is extinguished, so to speak, and ceases to be perceived; that is the point, definitely, where it is necessary to stop; it is only then required to read the figure of the division to which the arrow corresponds; that we suppose will be 25. The annexed table shows to what degree of richness, or to what proportion of cream, the figure corresponds.

"The light ought to be placed at about a metre (at least three feet) from the observer; a greater distance will not impair the accuracy of the operation, but it is not the same if one looks from too near.

"One may assure himself of the accuracy of the instrument by adding a very small quantity of water, or even gruel, to the milk. Twenty degrees of water are sufficient to change the transparency of the liquid; thus milk marking 25, will mark 28 or 30 on mixing with it a little water.

"At the moment when the milk is introduced between the two plates of glass, it commonly happens that bubbles of air are enclosed in the layer of liquid; it is necessary to drive them out, and this is easily done by impressing certain movements on the milk, by separating more or less the eye-piece so as to cause the two plates of glass to withdraw and approach each other alternately. When the trial is terminated, the eye-piece is to be removed so as to clean the instrument perfectly, and to wipe the glasses; the glasses ought always to be very bright, and one ought to avoid, during the observation, to tarnish with the breath the glass of the eye-piece."

Table indicating the Richness of different Kinds of Milk after the Degree which they show on the Lactoscope.

Milk of cow, giving about 5 per cent. of cream, shows 40 to 35 on the lactoscope.

Ditto ditto, ordinary, giving from 5 to 10 per cent. ditto, shows 35 to 30 on the lactoscope.

Ditto ditto, sufficiently rich, giving from 10 to 15 per cent. ditto, shows 30 to 25 on the lactoscope.

Ditto ditto, very rich, giving from 15 to 20 per cent. ditto, shows 25 to 20 on the lactoscope.

Ditto ditto, excessively rich (last extraction), shows 20 to 15 on the lactoscope.

Ditto ditto, very weak (first extraction), shows 150 to 3 on the lactoscope.

Milk of the common ass, of good quality, shows from 50 to 80 on the lactoscope.

Ditto, very weak, shows from 150 to 20 or 4 on the lactoscope.

Milk of goat, rich, shows 10 to 15 on the lactoscope.

Milk of woman, rich and substantial, shows 20 to 25 on the lactoscope.

Ditto, medium, shows 30 to 35 on the lactoscope.

Ditto, weak, shows 40 to 45 on the lactoscope.

It must be remembered that the lactoscope has regard only to one element of milk, and does not estimate the amount of sugar or cheese. M. Donné entertains the greatest confidence in the indications which it affords.

The construction of the instrument, and mode of employment, will be more clearly understood from an examination of the woodcut on the preceding page.

Some persons form their judgment of the quality of milk simply by its density, regarding all samples which do not indicate a certain specific gravity of inferior quality. We have already seen that this method is very fallacious, and that by it some milks, rich in cream, would be pronounced of inferior quality, in consequence of their low density; while others deficient in that constituent, would be declared of superior quality, on account of their high density.

Others rely upon the indications afforded by the lactometer, which also has its fallacies, but which are not so great when the instrument is used with the necessary precautions, as those relating to the specific gravity of milk. Like the lactoscope of M. Donné, the lactometer has regard to only one component of milk — namely, the fatty matter.

The following facts will show how fallacious is the lactometer in some cases. We have met with several samples of genuine milk, which gave only three or four per-centages of cream, but which yet possessed a specific gravity of 1830; judged by the lactometer test alone, such milks would be pronounced by all to be very poor, and by some even to be adulterated. Now this conclusion would be to a very great extent erroneous; for such milks, although certainly deficient in butter, have the full proportion of the remaining constituents — namely, the cheese, and the sugar. Again, we constantly meet with samples of milk giving six, eight, or more per-centages of cream, and which nevertheless, as shown by the specific gravity of the serum, are unquestionably adulterated with large quantities of water.

The observer who relied upon the indications of the lactometer would have regarded such samples as of average quality. The inquirer, therefore, should not rely solely upon the specific gravity or lactometer tests, but in all cases employ both, the one acting as a corrective of the fallacies of the other.

For all practical purposes, the above methods of examination are sufficient. Should it be desired to institute a very careful analysis, we may then adopt the processes described by Haidlen already given.

On the Adulterations of Milk.

The most prevalent and important adulteration of milk is that with *water:* now some few persons who have not reflected closely upon the matter, may be disposed to make light of the adulteration of milk with water, and to speak in rather facetious terms of the cow with the iron tail; but it is surely no light matter to rob an important article of daily consumption, like milk, of a large portion of its nutritious constituents.

But the adulteration with water is not the only adulteration to which milk is liable; the large addition of water frequently made to it, so alters its appearance as to cause it to assume the sky-blue colour so familiar to us in our schoolboy days, and so reduces its flavour, that it becomes necessary to have recourse to other adulterating ingredients, namely, *treacle*, to sweeten it; *salt*, to bring out the flavour; and *annatto*, about which we shall have much to say hereafter, to colour it.

Further, there is no question but that *chalk*, *cerebral matter*, and *starch* have been and are occasionally, though rarely, employed in the adulteration of milk, although it has not happened to ourselves to meet with these substances in milk.

Starch and cerebral matter have been met with at different times by more than one observer. Professor Queckett has in his possession some drawings made from samples of adulterated milk, showing the presence of both starch and cerebral matter.

With regard to the use of chalk, a manufacturer of preserved milk recently informed us that it sometimes happened to him to find carbonate of lime or chalk at the bottom of the evaporating dishes or pans on the evaporation of large quantities of London milk.

There is also good reason for believing that *turmeric* as well as annatto are sometimes used to colour milk and cream; also gum *tragacanth* to thicken cream, and *soda* to prevent its becoming sour.*

---

* Mr. Gay states that milk is sometimes adulterated with decoction of boiled white carrots.

Further, it has been stated that gum, dextrine, and emulsion of hemp seed have been employed; the use of the latter article is but little probable.

A practice frequently resorted to, although it is not an adulteration, should here be mentioned; a part or even the entire of the cream is removed, and the skimmed milk, mixed with some fresh milk, subsequently sold as whole milk.

An ingenious writer, whose name we do not at the present moment remember, has considered the subject of the supply of London with milk statistically, and he has arrived at the conclusion that the number of cows supplying London is not more than sufficient to provide each person with about a tablespoonful per day. If this statement is correct, some idea may be formed of the extent to which water is made to do duty for milk.

The results of the examination of Twenty-six samples of London milk were,—

That *Twelve were genuine*, but of these two showed a deficiency of cream.

That *Fourteen were adulterated*, the adulteration consisting principally in the addition of *water*, the per-centages of which ranged from 10 to 50 per cent. or one-half water.

The specific gravities of the *milks* varied from 1030 to 1015, of the serum from 1028 to 1016, the cream from 29 to 2 per-centages, the average being nearly 10 per-centages.

On the Detection of the Adulterations of Milk.

The articles employed in the adulteration of milk, the methods for the discovery of which we have now to describe, are water, sugar including treacle, salt, annatto, turmeric, gum tragacanth, starch, cerebral matter, and chalk.

Certain alleged adulterations of milk, either not likely to be practised, or but rarely resorted to, it is not necessary to notice.

There are two general methods by which the fact of the adulteration of milk may be determined; the one indirect, as by a quantitative analysis of the milk for its more important constituents, and by the deficiency of one or more of which the existence of adulteration may be inferred; the other direct, as by detection, either through chemistry or the microscope, of the adulterating substance or substances.

In some cases these two methods may be combined.

The methods by which the normal constituents of milk may be determined quantitatively have already been described.

On the Detection of Water.—Milk being much heavier than water, when that liquid is added to it the specific gravity of the mixed article is less than that of genuine milk, and the diminution, within certain limits, is proportionate to the quantity of water added. In the knowledge of these facts, we are furnished with a method whereby the adulteration of milk with water may be determined quantitatively.

This may be done by taking the specific gravity of either the entire milk, of skimmed milk, or, still better, of the serum.

According to M. Lassaigne, pure milk at 50° F. —

Has a specific gravity of - - -	1031
With 25 parts of water - - -	1021
With 33 parts of water - - -	1020

According to our own experiments, the following are the ordinary specific gravities of *milk* adulterated with various proportions of water: —

Water per Cent.	Sp. Gr. of Milk.
Water none - - - -	1030
About 15 parts - - - -	1026
About 20 - - - -	1023
About 35 - - - -	1018
About 45 - - - -	1015

But since the specific gravity of even genuine milk is subject to wide ranges, in certain exceptional cases, owing to the variable quantities of fatty matter present, it is in all cases better to take the specific gravity of either skim-milk or the serum.

The specific gravity of *skim-milk* with various proportions of water, as deduced from the centesimal galactometer, is as follows: —

Water.	Skim-Milk.	Sp. Gr. of Skim-Milk.
None - -	100 - -	31
10 parts - -	90 - -	27
20 - - -	80 - -	25
30 - - -	70 - -	21
40 - - -	60 - -	19
50 - - -	50 - -	16

Results still more accurate may be obtained by taking the specific gravity of the *serum* of milk, since this is subject to much less variation than either the whole or skim-milk. The casein and butter are easily removed by the addition of a few drops of acetic acid, a quantity indeed so small as scarcely to affect the gravity of the serum.

The following table exhibits the results of various additions of water to the serum: —

Water.	Serum.
Pure	29
10 parts	25
20	22
30	20
40	17
50	14

In taking the specific gravity of the serum, and in determining from this whether water has been added or not, the only fallacy to which the observer is subject is that by the addition of saccharine matter, which would cause the serum to weigh heavier.

But in the case of whole milk there are other sources of fallacy to which reference to some extent has already been made, and against which it is necessary to guard.

Thus a milk may possess the proper specific gravity, and yet be deficient of cream, which may have been abstracted; again, it may be several degrees lighter than ordinary, and yet may be perfectly genuine, this arising from the presence of an unusual quantity of fatty matter.

In order to guard against these fallacies, therefore, it is always necessary not only to take the weight of the milk, but also to measure the quantity of cream, which should not be less than 8 per-centages.

The instruments by which the weight of milk is taken and the cream measured have already been described.

One method by which the quantity of water may in general be indirectly estimated is, by determining quantitatively the amount of sugar present.

On the Detection of Sugar.—The sugar used is usually brown sugar or treacle: the presence of these may in general be determined as follows:—The casein and butter are to be precipitated by means of acetic acid, and the serum evaporated, a very gentle heat only being used, and the colour of the residue particularly noticed; if it is darker than ordinary, the presence of sugar may be suspected. The residue may then be dissolved in distilled water, a little yeast added, and the solution exposed for some hours at a temperature of between 70° and 80° F. If fermentation ensues "it is a sure sign of the presence of sugar, for milk sugar cannot ferment, at least in so short a time, and the fermentation is never brisk. But the smallest proportion of sugar, either grape or cane sugar, very speedily gives rise to a tumultuous fermentation."—*Normandy.* The carbonic acid may be collected, and the sugar calculated either from it or from the alcohol formed.

If cane sugar, or decoction of *carrots* which contains it, has been added, perhaps the best method of proceeding is the following: remove the sugar of milk by means of Fehling's solution, and afterwards determine whether cane sugar is present by the fermentation test.

On the Detection of Starch. — For the detection of starch in milk and cream, the microscope furnishes the readiest and most certain means. A little of the milk, spread out in a very thin stratum, should be examined under the microscope, the examination being aided by the use of tincture of iodine. For the quantitative determination of the starch, which will not often be required, we may proceed as follows: the curd is to be separated by means of acetic acid, collected on a filter, dried, and treated with ether; this will remove the fat, and the starch and casein only will remain. Lastly, the casein may be removed by means of a weak solution of potash. A more accurate plan is to convert the starch into grape sugar, and to calculate its amount from this. The sugar of milk must first be removed from the evaporated milk by digestion with alcohol, and the processes followed for the conversion of starch into sugar, and the determination of its amount, described in the article Sugar.

On the Detection of Gum Arabic and Gum Tragacanth. — The serum of milk is to be evaporated, and the residue boiled and digested with alcohol, which will take up the sugar and leave the gum. Or alcohol may be poured into the whey, the gum will be precipitated, and, when dried, may be identified by its appearance.

For the detection of gum tragacanth we are recommended to boil the milk, and leave it at rest for some hours, when a gelatinous translucid deposit will be formed, which, being washed with a small quantity of water and tested by a few drops of solution of iodine, produces a blue colour because gum tragacanth contains starch. The starch is plentiful and is in the form of starch corpuscles; these are rather small, but vary much in size; many are irregular, some are rounded, others are somewhat polygonal, while a few are muller-shaped: in the more perfect grains a rounded hilum is distinctly visible.

On the Detection of Cerebral Matter. — The presence of cerebral matter in milk may be determined with certainty by means of the microscope, portions of the nerve tubules being readily discovered with that instrument, as shown in the engraving. *Fig.* 73.

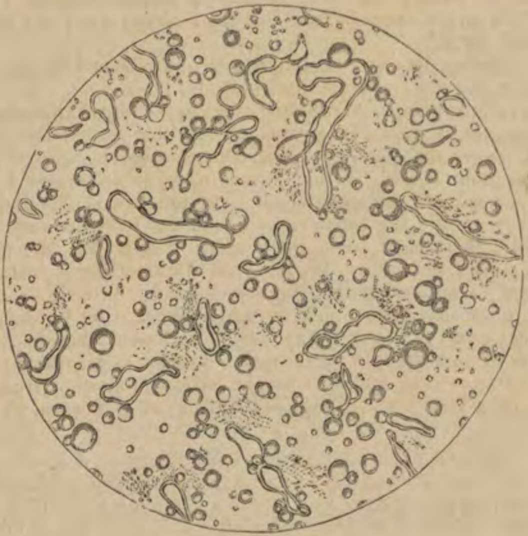
On the Detection of Chalk. — If the milk be diluted with water and set aside for some hours, part of the chalk, if present, will have subsided as a precipitate, when it may be sufficiently identified by its appearance and its effervescence with acids. Or a portion of the milk may be evaporated to dryness, the residue incinerated, and the chalk estimated from it in the manner pointed out in the article on Tea.

On the Detection of Salt.—This must be determined from the ash by the process described under Annatto. The saline taste of the ash will show the presence of salt if that substance has been employed.

On the Detection of Annatto. — The presence of annatto is rendered probable when the milk evaporated down to a small quantity presents a reddish or orange-red colour; if this colour is materially altered on the addition of an acid and an alkali to the milk, being rendered purplish by the one and of a brighter red by the other, its presence is certain. Lastly, by means of alcohol, the colouring matter may be dissolved out of the soft residue of evaporated milk, and the effects of the reagents mentioned tried upon the alcoholic extract.

Fig 73.

MILK ADULTERATED WITH SHEEP'S BRAINS.



On the Detection of Turmeric.—If turmeric has been used in substance to colour milk, it would be possible to detect in some cases the turmeric cells. However, it is best in all cases to proceed by the method indicated for the discovery of annatto. The chief difference is that the turmeric is rendered deep brown by alkalies.

It is of course rarely, if ever, necessary to examine milk for more than two or three of the articles above enumerated. In general it is sufficient to determine whether water, the ordinary adulteration of milk, has been added or not.

The following statistics regarding the quantity of milk consumed are by Mr. Braithwaite Poole. The consumption in the United Kingdom, excluding cheese, butter, &c., is taken at about 1150 million quarts annually.

" Mr. Poole assumes that an average milk cow yields 7 quarts of milk as a daily average, and that the retail price is 3*d.* per quart; and from these data a result is arrived at, that the whole supply requires 450,000 milch cows, and that the retail value amounts to the prodigious sum of 14,000,000*l.* per annum.

"But limiting the inquiry to London, the same authority assumes that the carefully reared cows that furnish most of the supply for the metropolis yield 9 quarts per daily average; that the number thus employed is 24,000; that the quantity of milk consumed is about 180 million quarts annually, and that the consumers pay not less than 1,600,000*l.* for it."

The following details respecting the cost of milk, and its conveyance to London, are also on the authority of Mr. Poole.

"The railway companies usually charge at the rate of three farthings per gallon, for carriage, if the distance be within forty miles, and 1*d.* if for a longer distance; returning the empty cans free of charge. Now this milk is sold by the farmers to large dealers at from 5*d.* to 7*d.* per gallon; the dealers sell it to retailers at from 7*d.* to 9*d.* per gallon; while the retailers sell it to the housekeepers of the metropolis at from 3*d.* to 4*d.* per quart. Nor is this all; the neat milk at say 8*d.* per gallon, becomes too often milk and water at 4*d.* per quart. Considering that cream commands a price of from 2*s.* to 3*s.* per quart in London, milk certainly cannot bring in less than 5*d.* to 6*d.* per quart to the retailers. It is estimated that in 1853 the quantity of milk brought by railway to London considerably exceeded 3,000,000 quarts, of which by far the largest proportion travelled on the Eastern Counties Railway."—*Dodd's Food of London.*

FLOUR AND BREAD, WITH THEIR ADULTERATIONS.

The word Bread, adopted as the heading of this article, is employed in a generic sense, and is intended to include the several varieties of bread prepared from the flours of the seeds of the different grasses employed for bread making.

As bread is made from flour of various kinds, it is necessary to take into consideration, in the first place, some particulars in relation to the several kinds of flour, as their chemical composition, microscopical structure, and their properties and differences.

While there are important distinctions to be noticed between each of the flours employed in the manufacture of bread, there are also certain points of resemblance.

Thus every flour used in the preparation of bread consists of *nitrogenised* and *non-nitrogenised* elements or constituents: the former are vegetable *fibrin*, *albumen*, *caseine*, &c., which have been named after the corresponding proteine compounds existing in animal substances: the latter are *starch*, *dextrine* or *gum*, and *sugar* — products more particularly of the vegetable kingdom.

The chief flours are those of wheat, barley, rye, oat, Indian corn, and rice.

WHEAT FLOUR.

There are several distinct species of wheat: that which is chiefly cultivated in this country is the *Triticum vulgare;* of this there are two varieties — *T. æstivum*, or summer wheat; and *T. hybernum*, or winter wheat: the former is sown in the spring, and the latter in the autumn. Of these varieties, again, there are several modifications, into the description of which it is, however, not necessary to enter on the present occasion.

Wheat seeds or grains, as brought to the market, and as supplied to the miller, are deprived of their *paleæ*, or husks.

The number of parts into which ground wheat is separated, and the amount of each yielded by given quantities, vary according to the characters of the wheat, and the processes adopted by different millers.

In wheats which are hard, the integuments separate with difficulty, and therefore the flour produced from these usually contains a greater proportion of adherent bran than do those flours procured from wheats which are soft, and which part with their epidermic coverings more readily.

According to Mr. Hard, a miller of Dartford, in Kent, the following are the products, with the quantities obtained, of one quarter, or eight bushels of ground wheat: —

"*Produce of One Quarter of Wheat, weighing* 504 *lbs.*

Flour - - - - - -	392 lbs.
Biscuit, or fine middlings - - - -	10 „
Toppings, or specks - - - - -	8 „
Best pollard, Turkey pollard, or twenty-penny -	15 „
Fine pollard - - - - -	18 „
Bran and coarse pollard - - - -	50 „
Loss sustained by evaporation, and waste in grinding, dressing, &c. - - - - -	11 „
	504 lbs."

As it is frequently a matter of much importance to determine the composition of samples of wheat flour, we will now describe the various steps by which the analysis may be effected.

A weighed quantity of flour is to be made into a paste, and well kneaded, either on a sieve or in a piece of muslin, water being poured over it until it ceases to acquire a milky colour; the water carries away the starch, and dissolves out the albumen, sugar, gum, and salts, while the mass left on the filter consists of "crude gluten."

This *crude gluten* is itself, however, compounded of no less than four distinct substances—viz., gluten, vegetable fibrine, a very small quantity of mucine or caseine, and oil, in the following proportions :—

Gluten - - - -	20
Vegetable fibrine - - -	72
Mucine (caseine ?) - - -	4
Oil - - - - -	3·7
Starch (accidental) - - -	a small quantity.
Crude gluten - - -	99·7

Gluten. — This substance is obtained by boiling crude gluten in alcohol, which extracts the gluten, caseine or mucine, and the oil. The caseine is deposited on cooling, and, after separation, the residual liquid is evaporated until an adhesive mass is obtained, from which the oil is extracted by ether, and gluten alone remains.

Vegetable Fibrine.—This is insoluble in alcohol, and forms the chief part of the crude gluten; it is left nearly in a pure state after the action of that reagent. It much resembles in its composition muscular fibre.

For the other constituents of wheaten flour we must search in the water, which has passed through the sieve.

Starch.— The starch, after remaining suspended for a time in the water, subsides, forming a precipitate; this may be readily obtained, and, after drying, its amount determined by weighing.

Vegetable Albumen. — This substance is procured by boiling the water, whereby the albumen is coagulated, and forms shreds or flakes, which rise to the surface, where they collect as a pellicle.

Caseine. — After the separation of the albumen, a little acetic acid is to be added, which throws down the caseine. The mucine (or caseine ?) present in crude gluten is soluble in alcohol, from which, on cooling, it is thrown down in the form of white flocculi.

Oil. — The greater part of the oil is present in the outer part of the grain, from which it follows that the bran contains a larger proportion of oil than the central part of the grain. It is best obtained by digesting whole or bruised wheat in ether. When wheat paste is washed in water, part of the oil passes away with it, and part remains in the crude gluten.

Sugar. —The sugar present in wheaten flour is of the kind denominated *glucose;* its amount is determined by evaporating the water to dryness, and dissolving the sugar out of the residue by means of alcohol, which being in its turn evaporated, the sugar is deposited in a granular or semi-crystallised state, and may be collected and weighed.

Gum.—The remaining part of the residue of the evaporated water consists of gum or dextrine, insoluble in alcohol; this also should be dried and weighed.

Water.—The quantity of water present in wheat, on an average, varies from fifteen to seventeen per cent., and is greater in new than in old wheat, and it is this circumstance which makes the former of less value than the latter.

Mineral and Saline Constituents.—The more important of these are silicate of potash, and the alkaline and earthy phosphates, which are present in considerable amount. For ordinary purposes it is not necessary to make so precise an analysis as that indicated above; it will be sufficient to ascertain the amount of crude gluten present in a given quantity of flour.

To determine the quantity of this gluten, a little instrument has been invented by Mr. Boland, termed an "*aleurometer*."

Of this instrument the following description is given by Mr. Mitchell:*—

"It consists of a hollow copper cylinder, about six inches long, and from three-quarters of an inch to an inch in diameter. It has two principal parts; the one, about two inches long, is closed at one end, forming a kind of cup capable of containing about 210 grains of fresh gluten; it screws into the remainder of the cylinder. The cylinder being charged with gluten, is heated to about 420° in an oil-bath. The gluten by this treatment swells, and according to its rise in the tube (which may be measured by a graduated stem) so is its quality. Good flours furnish a gluten which augments to four or five times its original bulk; but bad flours give a gluten which does not swell, becomes viscous and nearly fluid, adhering to the sides of the tube, and giving off occasionally a disagreeable odour, whilst that of good flour merely suggests the smell of hot bread."

The proceeding adopted by the corn-chandler and the baker for the determination of the quality of wheaten flour is still more simple.

A small quantity (a few grains is sufficient) is made into a paste with water, and its quality judged of by the tenacity of the dough, the length to which it may be drawn into a thread, or the extent to which it may be spread out into a thin sheet.

The following analyses by Dumas show the composition of 100 parts of wheat flour:—

Wheat Flour.		*Odessa Flour* (Flinty).		*Odessa Flour* (Soft).	
Water	10·00	Water	12·00	Water	10·00
Gluten	10·96	Gluten	14·55	Gluten	12·00
Starch	71·49	Starch	56·50	Starch	62·00
Sugar	4·72	Sugar	8·48	Sugar	7·36
Dextrine	3·32	Dextrine	4·90	Dextrine	5·81
	100·49	Bran	2·30	Bran	1·29
			98·73		98·46

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* Treatise on the Falsification of Food, p. 48.

Wheaten flour contains a greater amount of proteine or nitrogenised compounds — that is, of blood and flesh making principles — than any other description of farina.

Other analyses of wheat and the rest of the cereal grains will be found at p. 257.

Structure of the Grain of Wheat.

Several structures enter into the formation of the seed or grain of wheat, as well as that of the other cereals.

First, the seed is surrounded by membranes, called the testa; second, the surface of the seed proper is formed of angular cells, filled with glutinous and oily matter in a granular state; while the substance of the seed is made up of cells filled with starch corpuscles. Now each of the parts enumerated differ, for the most part, in the different cereal grains.

The testa, is in part but not entirely removed in the process of grinding and dressing the flour, and the same is the case with the cells forming the surface of the grain.

The following is the exact structure of the grain of wheat: —

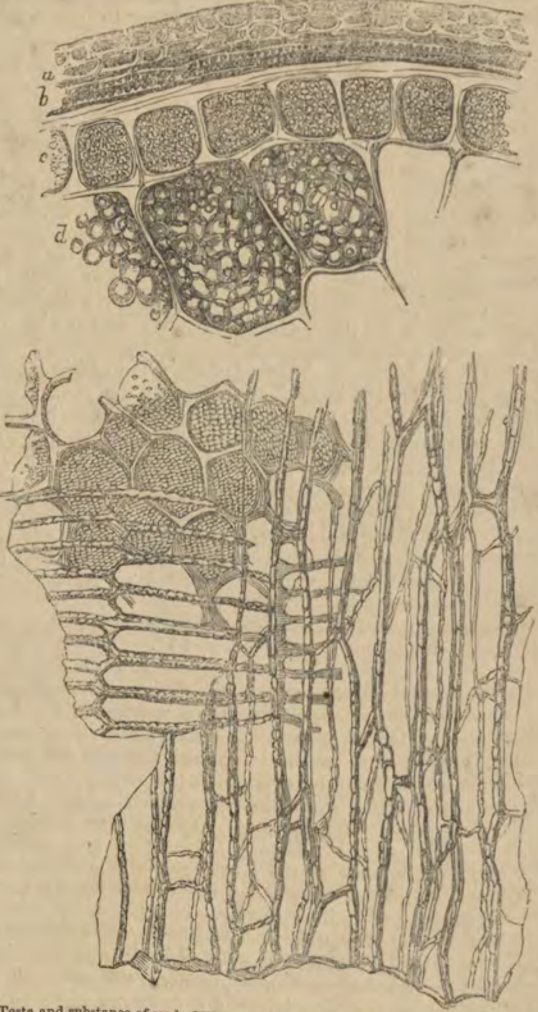
The testa, covering the immediate surface of the seed, consists of three layers of cells, two of which are disposed longitudinally to the axis of the seeds, and, other transversely. The longitudinal cells are large, and the margins distinctly beaded, especially the outer layer; the transverse cells are also beaded, but to a less extent.

The cells forming the surface of the seeds are large and angular; those of its substance are still larger, and each encloses a considerable number of starch corpuscles, which are smaller near the outer parts of the grain than towards the centre. These several layers of cells may be described as three distinct membranes.

The structure of the testa and of the substance of the seed are exhibited in the engravings. *Figs.* 74. and 75.

Viewed with an object-glass magnifying 420 diameters linear, wheat starch is observed to consist of definite grains or particles; many of these are very small, others are of considerable dimensions, while there are but few of intermediate sizes: the small grains are chiefly round, rarely oval, or muller-shaped, and for the most part provided with a central spot or hilum: the larger granules form rounded or flattened discs, with thin edges. Neither hilum nor concentric rings are *in general* perceptible on the larger discs, although in some few a central tubercle may be seen as well as indistinct annuli. Occasionally some of the larger granules are more or less twisted or turned up at the edges, and when seen sideways, present the appearance of a longitudinal furrow, which has been erroneously described as a hilum: this appearance is, however, deceptive; it is really occasioned by the partial folding or curling of the grain on itself, whereby a central depression is produced, the corpuscle at the same time being viewed obliquely. We have frequently seen grains which when stationary presented a round and disc-like appearance, but which, in rolling over and presenting the edges to view, exhibited

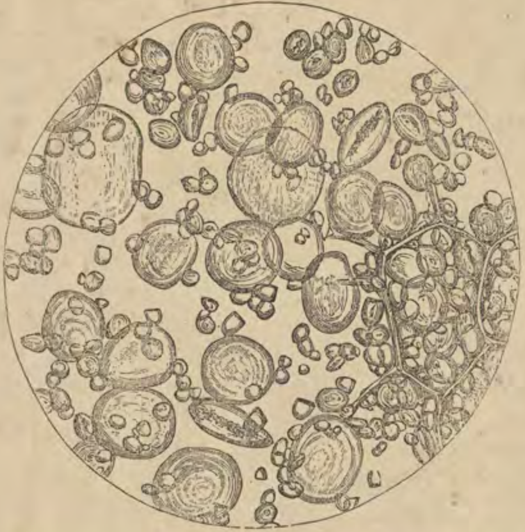
Fig. 74.



Testa and substance of seed of WHEAT. *Transverse* and *vertical* sections: *a a*, outer membrane; *b b*, middle; *c c*, inner membrane or surface of the seed proper. Magnified 200 diameters.

the longitudinal furrow described, an observation which clearly proves its nature. A few granules attain a very considerable size; these

Fig. 75.



This engraving represents the structure and appearances of the starch granules of WHEAT FLOUR, as also the characters of the *cellulose*. Drawn with the Camera Lucida, and magnified 420 diameters.

are less regularly circular, and being much flattened, reflect but little shadow; sometimes their edges are faintly marked with radiating lines. Examined with the polariscope they exhibit a well marked cross. Many of the above described particulars, as also the characters of the cellulose, are well exhibited in *fig*. 75.

BARLEY FLOUR.

There are several distinct species of barley; that, however, which is commonly cultivated in this country is the *Hordeum distichon*, or two-eared barley.

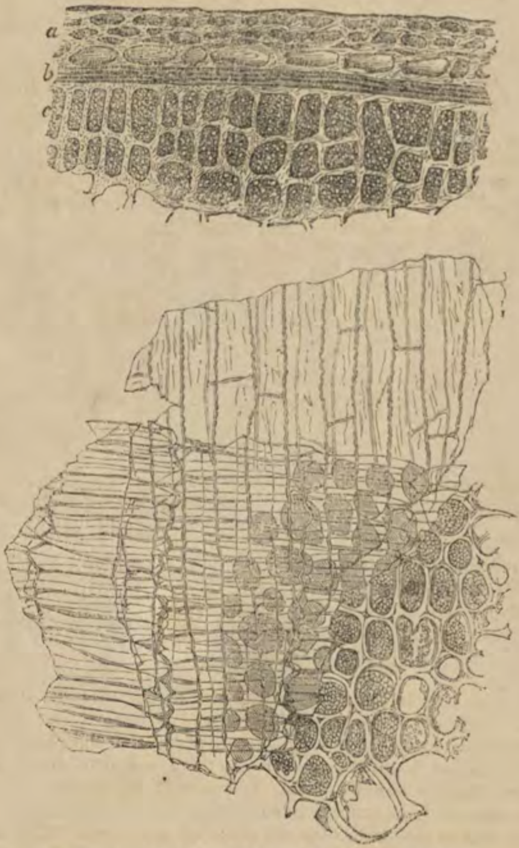
As met with in commerce the seeds or grains are usually enclosed in the *paleæ* or husks; denuded of these they form "*Scotch* or *pot barley*," when rounded they constitute "*pearl barley*," and this again reduced to powder is called "*patent barley*."

The analysis of barley flour must be conducted very much in the same manner as that of wheat flour.

Chemical Composition.

The proportion of azotised compounds in barley is less than in wheat flour; it is deficient particularly in crude gluten, so that barley paste may be nearly all washed away in water.

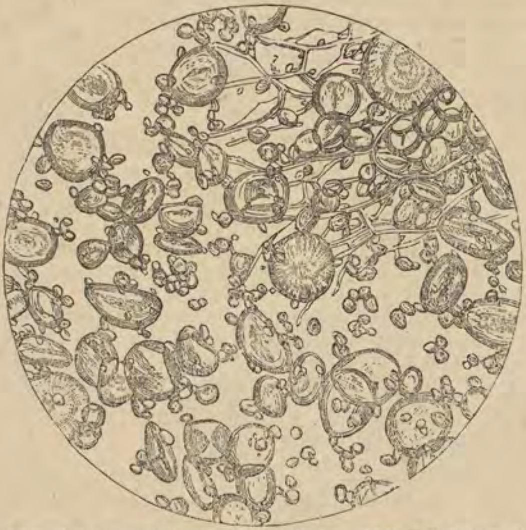
Fig. 76.



Testa and surface of seed of BARLEY. Magnified 200 diameters.

The milky fluid obtained by washing barley paste, deposits, as well as the starch, a proteine matter supposed to be *insoluble caseine* : if this be digested with a solution of ammonia it is dissolved, but is again thrown down on the addition of acetic acid; the liquid which has deposited the starch and insoluble caseine still holds in solution a small quantity of albumen and some soluble caseine.

Fig. 77.



This engraving represents the structure and characters of BARLEY STARCH, together with the *cellulose*. Drawn with the Camera Lucida, and magnified 140 diameters.

Barley flour is less nutritive than wheat flour; its starch corpuscles are less soluble, and therefore resist more the action of the gastric juice; the husk "is slightly acrid," and it is somewhat laxative.

Structure of the Grain of Barley.

The testa of the grain of barley differs considerably from that of wheat. It consists usually of four layers of cells: they are smaller than those of wheat; the longitudinal cells, of which there are three layers, are not beaded, but those forming the outer layer have their margins slightly waved; those of the inner layers and of the transverse cells not being even waved.

The cells of the surface of the grain are not nearly so large as those of wheat, and they form three layers, in place of one as in wheat. Those of its substance also differ from the corresponding cells of wheat, being more delicate, and presenting, when emptied of starch, a fibrous appearance.

The starch granules of barley resemble very closely in form and structure those of wheat, so that the description already given applies to some extent to the starch of barley.

Barley starch consists of small and large grains, with but few of intermediate size: the former, it is to be particularly observed, are three or four times smaller than the corresponding grains of wheat starch; and of the larger grains many are distinctly ringed, while a much greater proportion of them presents the longitudinal furrow, the nature of which has already been described. These characters are sufficiently well marked to allow of the discrimination by the microscopist of wheat and barley flour or starch. Examined with the polariscope, they exhibit a cross not nearly so strongly marked as in rye.

Considerable difference is observed between wheat and barley flour in the action upon them of boiling water and some other reagents; thus, after prolonged boiling, in the case of barley flour, a substance remains undissolved, which has been denominated "*hordeine*," whereas wheat flour treated in the same manner is nearly all dissolved.

By the above characters, particularly by the minuteness of the small grains, and by the structure of the testa, barley starch or meal may be readily and satisfactorily discriminated when mixed with wheat flour.

Rye Flour.

The grass from which rye is obtained is the *Secale cereale.*

The seeds or grains resemble those of wheat, but are smaller.

The analysis of rye flour must be conducted much in the same manner as that of wheat and barley flour.

Rye flour is rather less rich in nitrogenised products than wheat flour, but it contains more sugar; its paste, when repeatedly washed in water, breaks up, and becomes diffused throughout the liquid, the bran only being left behind; the milky liquid, after having deposited the starch, and after the separation of the albumen, is to be evaporated, when the residue will consist of sugar, oil, and the so-called "*soluble gluten*," which may be dissolved out by means of alcohol.

Rye flour is said to be somewhat laxative.

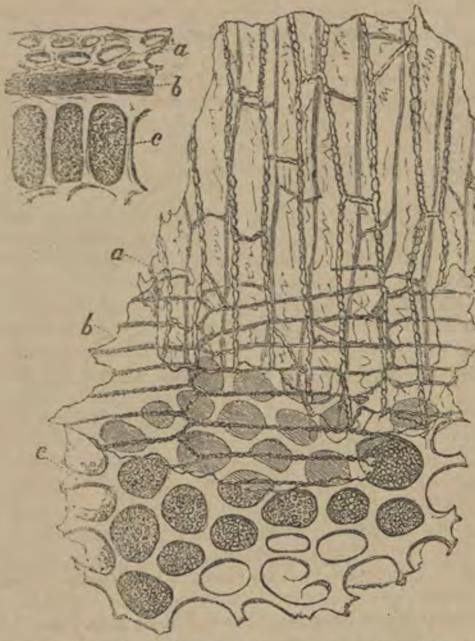
The roasted grains are not unfrequently employed in the adulteration of coffee.

Structure of the Grain of Rye.

The testa of rye approaches somewhat closely in structure to that of wheat, as is evident on an examination of the subjoined engraving. There are, however, certain differences: thus, the cells of the first and second coats are smaller and much more delicately beaded; those of the third coat are also smaller and of a somewhat different form.

The starch granules of rye flour bear a general resemblance in form and size to those of wheat: there are these remarkable and satisfactory differences, however—viz., that the lesser grains are decidedly smaller than the corresponding grains of wheat, and that many of the larger granules of rye starch are furnished with a three or four-rayed hilum. Examined with the polariscope they exhibit a very strongly marked cross. *Figs.* 78. and 79.

Fig. 78.



Structure of testa of RYE. Vertical and transverse views : *a a*, outer ; *b b*, middle and *c c*, inner coats. Magnified 200 diameters.

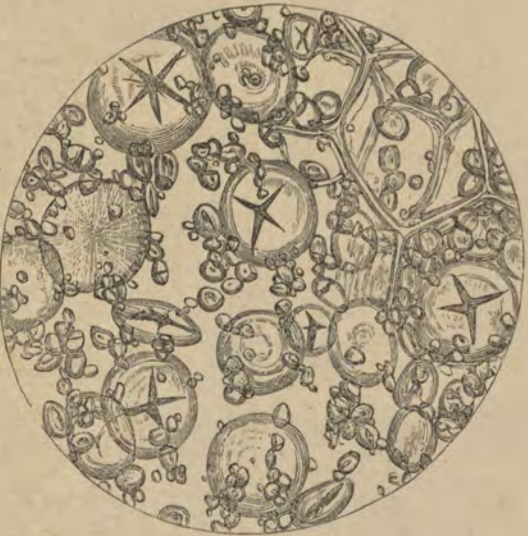
OAT FLOUR.

There are several distinct species of oats; that, however, which is chiefly cultivated in this country is *Avena sativa*.

The oat grains or seeds are usually enclosed in their husks; when deprived of these they form what are known as "*groats*," and these crushed constitute "*Embden groats*."

Oat flour or meal does not form a dough or paste like wheat flour; notwithstanding which, however, it contains a large amount of nitrogenised matter; this exists principally in the form of "*avenin*," a substance analogous to soluble caseine, and obtained in the same manner, by the addition of acetic acid.

Fig. 79.



This engraving represents the structure and characters of the starch granules of RYE FLOUR. Drawn with the Camera Lucida, and magnified 420 diameters.

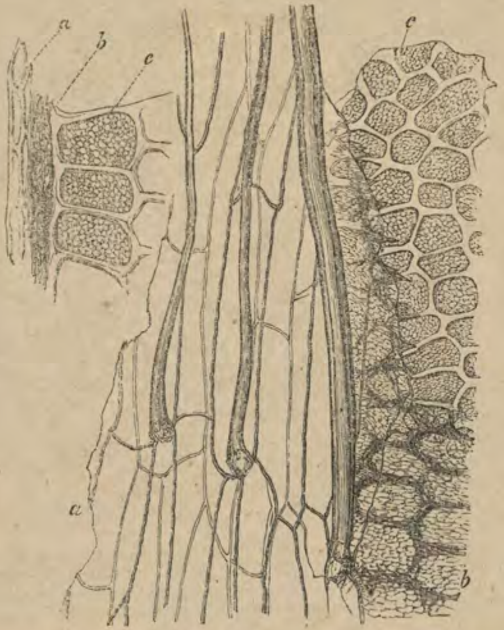
"Oatmeal," Pereira remarks, "is an important and valuable article of food. With the exception of maize or Indian corn it is richer in oily or fatty matter than any other of the cultivated cereal grains; and its proportion of protein compounds exceeds that of the finest English wheaten flour; so that both with respect to its heat and fat making, and its flesh and blood making principles, it holds a high rank."

Structure of the Grain of the Oat.

The *membranes* covering the grain of oat, contrasted with those of the other cereals, present several peculiarities.

The *longitudinal* cells forming the outer membrane are disposed in two layers; they are large and well defined, the walls being rather thin and slightly waved: from the upper and outer wall of some of the cells springs a single long and pointed hair, the points being turned towards

Fig. 80.



Testa of OAT. *a a*, outer; *b b*, middle; and *c c*, inner tunics. Magnified 200 diameters.

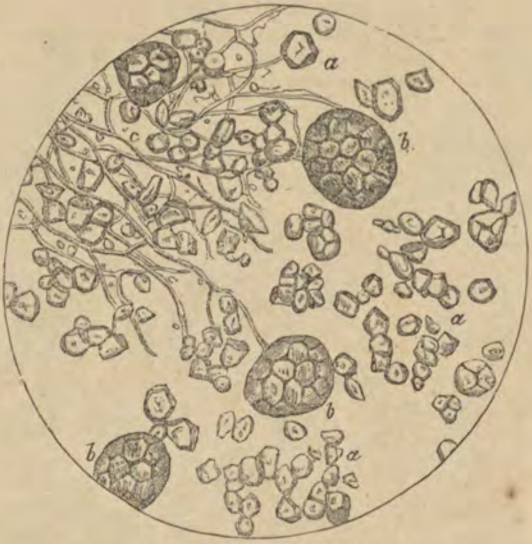
the summit of the grain; these hairs arise from the cells over the whole surface of the grain, but they become more numerous towards the apex, where they form a beard or tuft, as in wheat.

The *transverse* cells, which may be described as forming the second investing membrane, are disposed in a single layer; their walls are less accurately defined, and they are not very much longer than broad.

The *cells* forming the surface of the seed itself, and which may be described as the third covering of the grain, also consist of a single layer, and they are smaller than the corresponding cells of wheat.

The starch granules of the oat present well-marked structural characteristics. They are smaller in size than those of wheat, varying but little in dimensions, are polygonal in figure, without either visible concentric rings or hili, but with central depressions and thickened edges. The great peculiarity of oat starch, however, is, that many of

Fig. 81.



This engraving represents the structure and characters of the starch corpuscles of OAT FLOUR, as also of the *cellulose*. Drawn with the Camera Lucida, and magnified 420 diameters.

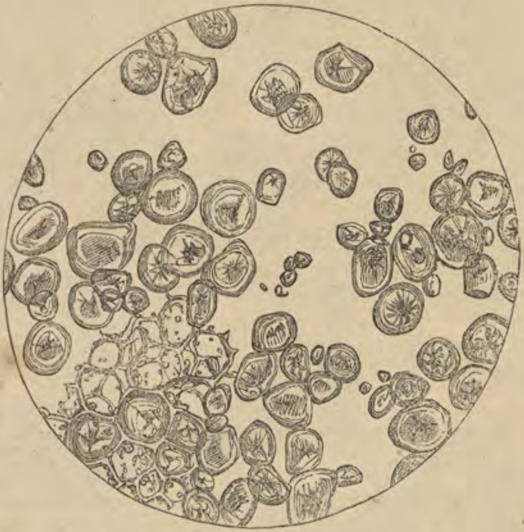
the grains cohere together, forming bodies of a rounded or oval figure, and presenting a reticulated surface, indicative of their compound structure. These bodies escape readily from the cellulose, and, when oat flour is diffused through water, may frequently be seen floating about freely in the liquid. A second peculiarity is, that unlike the other cereal starches, the grains of oat starch, when viewed with polarised light, do not exhibit the usual crosses. The above particulars are well exhibited in the accompanying engraving. The walls of the cells of the cellulose are very delicate, and appear, when the cells are emptied of the starch, like threads, as represented in the engraving.

A figure of oat starch is given in the new edition of Pereira's "Materia Medica." In this the larger grains are made fully equal in size to those of wheat starch; whereas they are really several times smaller, as represented in our engraving. This error has probably arisen from the artist having mistaken the compound bodies in question for single granules. The same error pervades some of the measurements given.

INDIAN CORN FLOUR.

Zea Mays, or Indian corn, is met with in the state of flour, in the shops, under the name of "*Polenta;*" it enters into the dietary of many of our public institutions and charities.

Fig. 82.



This engraving represents the structure and characters of the starch granules of INDIAN CORN FLOUR, including the *cellulose*. Drawn with the Camera Lucida, and magnified 420 diameters.

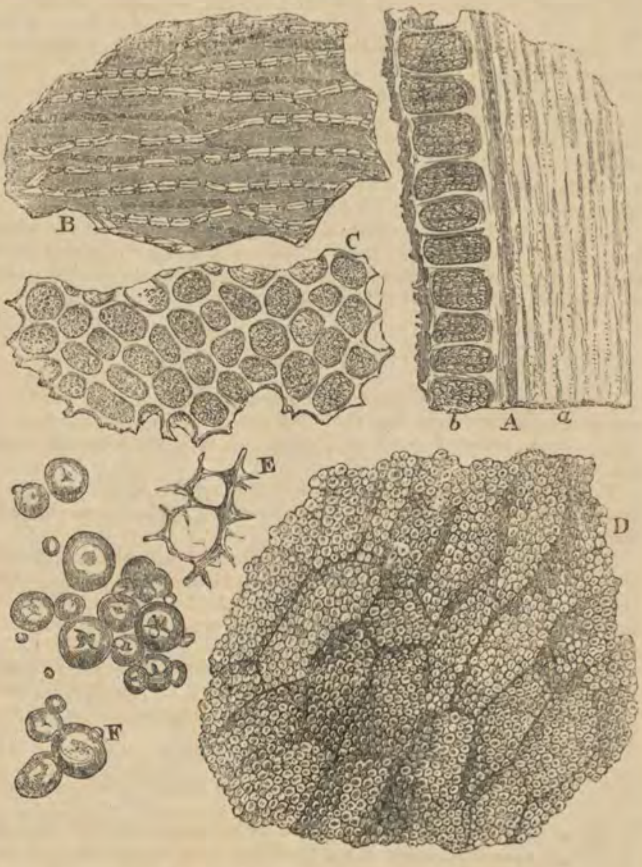
The amount of azotised constituents is less in maize than wheat; it contains, however, a larger quantity of oil, which accounts for its fattening properties.

In those unaccustomed to its use, maize is considered to excite and to keep up a tendency to diarrhœa.

Structure of the Grain of Indian Corn.

The testa of the grain of Indian corn is made up of two membranes; the *outer* of these consists of some seven or eight layers of cells, all running in one direction, and about three times as long as broad; the margins of the outermost layer are beaded, the beadings being remarkable for a certain squareness of outline.

Fig. 83.



A, transverse section of *testa* of INDIAN CORN. B, longitudinal view of cells of outer layer of testa; C, cells of *surface* of grain; D, cells of its *substance*; E, *blastema*; F, starch granules. A 100, B C 200, D 100, E F 500 diameters.

The *inner* membrane forms the surface of the seed proper, and consists of a single layer of cells resembling those of the other cereals.

The *cells* of the cellulose are very angular like those of rice, but they differ in being subdivided by numerous septa forming a cellulated network or blastema, each space inclosing a separate starch corpuscle.

The starch corpuscles of Indian corn bear considerable resemblance to those of the oat; like them, they are somewhat polygonal in outline, and present well-marked central depressions, as well as occasionally a divided and radiate hilum; they differ, however, in their much larger size, in not forming compound bodies, and in presenting under the polariscope well-defined crosses. The central depression appears to be a character in common between nearly all the starch granules of the cereal grasses. This depression, combined with the disc-like form of the grains, gives them a general resemblance to the blood discs of the mammalia. In those instances in which the grains, as in wheat and barley, are curved upon themselves, the depression exists of course only on one side of the disc.

Rice Flour.

The seeds of rice, *Oriza sativa*, contain a much less proportion of nitrogenised compounds than the other cereal grains, and particularly wheat — viz., about 7 per cent.: the quantity of fatty matter is also less.

The substance obtained from rice, termed gluten, is precipitable by acetic acid, and "has a creamy consistence, an agreeable smell, and a bland taste."

Much difference of opinion has prevailed in reference to the value of rice as an article of diet, some persons placing it very high. Analysis, however, clearly proves that it is the least nutritious of the cereal grasses: it usually contains 7 or 8 per cent. of gluten, and wheat flour rarely less than 12 per cent.

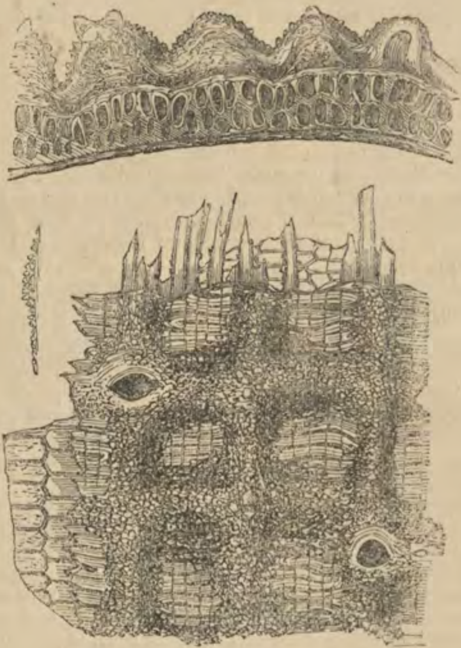
This difference of opinion has probably arisen from the fact, that rice is seldom eaten by itself, but is partaken of usually with milk, butter, or sugar, the nutritious properties of which substances have been attributed to the rice itself.

Structure of the Grain of Rice.

The structure of the husk of rice is by no means easy to determine; it is best examined after it has been immersed in glycerine for some time.

The outer surface of the seed is thrown up into ridges, these being arranged both transversely and longitudinally, and describing between them square spaces; the ridges are formed in part of silica in the form of granules; here and there are openings, of somewhat irregular

Fig. 84.

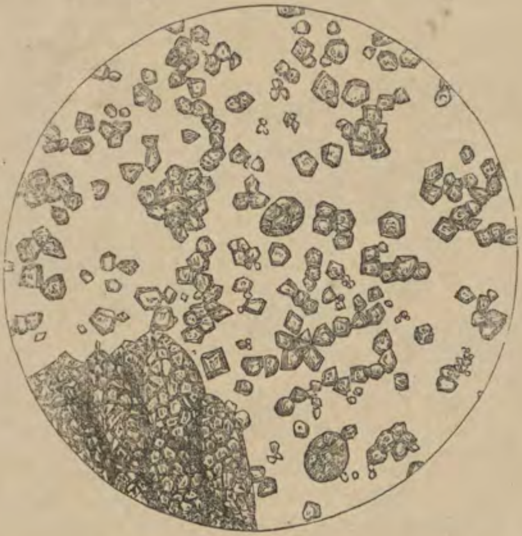


HUSK OF RICE, the upper figure being a transverse section. Magnified 220 diameters.

form, and which are the mouths of stomata: the substance of the husk is made up of narrow and rather short fibres; some of these are arranged longitudinally, others transversely; they are brittle, and their edges rough. That they really are fibres is shown by their being hollow, as is seen in transverse sections. Lastly, lying beneath the fibrous membrane is a thin membrane formed of angular cells, rather longer than broad, and the long axis of which is placed transversely. The above description is founded upon the admirable drawing made with the greatest care by Mr. Tuffen West.

The starch corpuscles of rice are small, and for the most part of an angular form, with well-marked central depressions and raised edges; they resemble closely the starch grains of the oat in their polygonal shape, but differ in being much smaller.

Fig. 85.



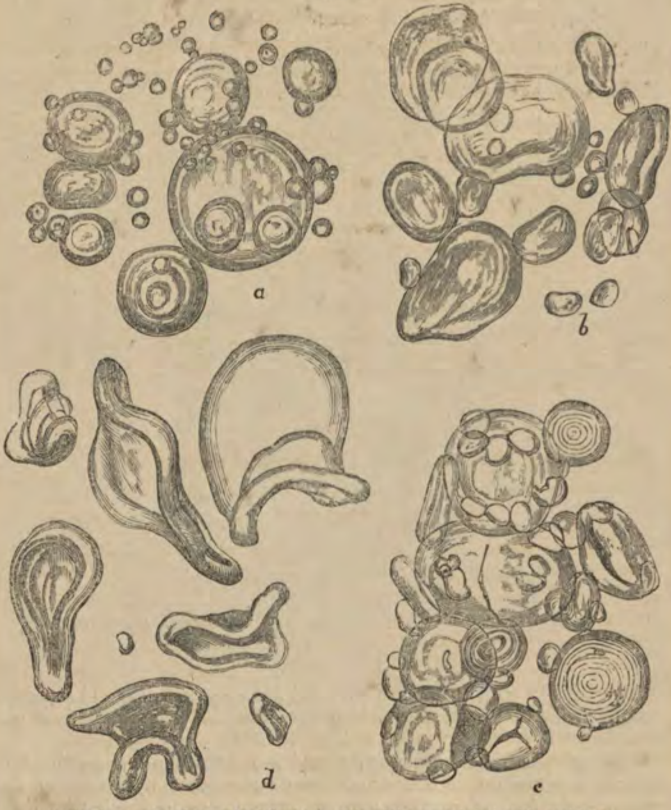
This engraving represents the starch corpuscles and cells of RICE. Drawn with the Camera Lucida, and magnified 420 diameters.

The cells in which they are enclosed are very angular, and separate readily from each other, in which respects also rice differs from oat flour.

Not only, as has been already stated more than once, can the different starches be discriminated from each other by means of the microscope, but in many instances the agencies to which they have been exposed may be determined, as will be clearly perceived on an attentive examination of the engraving. *Fig.* 86.

The differences between the raw, moist baked, and boiled granules are very marked: those of the dry baked are less marked; they are, however, on the average much larger than the raw granules, the form less regular, that of the smaller grains especially being a good deal altered; the shadows are less marked, and in some of the granules the concentric rings are rendered more conspicuous. To these variations in the condition of the granules of wheat flour a fifth might have been

Fig 86.



a, starch granules of *raw* wheat flour; *b*, ditto of the same *baked*, with moisture as in bread; *c*, *dry baked*; *d*, *boiled*, as in pudding. Magnified 400 diameters.

added representing the characters of the starch in *British gum* or *dextrine:* in this the granules are destroyed to a great extent, but here and there granules and portions of granules may be discovered, often exhibiting the concentric rings and sufficient to serve for its identification, and to determine whether the gum was made from wheat or potato flour.

It is by means of British gum that the backs of postage labels are rendered adhesive, as may be shown readily by submitting a small portion scraped from the label to examination with the microscope.

Composition of the chief Cereal Grains.

The following table, drawn up by M. Payen*, shows the proportions of the proximate principles contained in the chief cereal grains: —

100 Parts.	Starch.	Gluten and other azotised Matters.	Dextrine, Glucose, or other Congenerous Substances.	Fatty Matters.	Cellulose.	Silica, Phosphates of Lime, Magnesia, and soluble Salts of Potash and Soda.
Wheat, hard, of Venezuela	58·12	22·75	9·50	2·61	4·0	3·02
of Africa -	64·57	19·50	7·60	2·12	3·50	2·71
of Taganrog	63·30	20·00	8·0	2·25	3·60	2·85
demi-hard, of Brie, France	68·65	16·25	7·0	1·95	3·40	2·75
White tuzelle -	75·35	11·20	6·05	1·87	3·0	2·12
Rye - - - -	65·65	13·15	1·2	2·15	4·10	2·60
Barley - - -	65·43	13·96	1·0	2·76	4·75	3·10
Oats - - -	60·59	14·39	9·25	5·50	7·06	3·25
Maize - - -	67·55	12·50	4·0	8·08	5·90	1·25
Rice - - -	89·15	7·05	1·0	0·80	3·0	0·90

The following analyses are by Professor Johnston: —

	English Fine Wheat Flour.	Bran of English Wheat.	Scotch Oatmeal.	Indian Corn Meal.
Water - -	16	13	14	14
Gluten - -	10	18	18	12
Fat - - -	2	6	6	8
Starch, &c. - -	72	63	62	66
	100	100	100	100

It has been recently ascertained, by careful and repeated analyses, that the *bran* of wheat, as well as of most of the other cereals, contains a larger proportion of gluten than the rest of the grain, and consequently is more nutritious. It is of importance that this fact should be generally known, as the knowledge of it may serve in some degree to correct the preference given to very white bread, and the notion that whiteness and quality go together. The very reverse of this is often the case.

Professor Johnston gives the following as the relative proportions of gluten in the whole grain, bran, and flour of the same sample of wheat: —

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* Précis de Chemie Industrielle, p. 394. Paris, 1849.

Gluten of Wheat.

	Per Cent.
Whole grain - - -	12
Whole bran - - -	14 to 18
Fine flour - - -	10

By sifting out the bran, therefore, we render the meal much less nutritious; this will be more apparent when we state that the bran rarely forms less than one-fourth, and is often considerably more, of the whole weight of the grain.

The following is a more detailed analysis of the composition of wheat bran by Miller:—

Composition of Wheat Bran.

Starch - - - -	52·0
Gluten - - - -	14·9
Sugar - - - -	1·0
Fat - - - -	3·6
Woody fibre - - -	9·7
Salts - - - -	5·0
Water - - - -	13·8
	100·0

It has been recently stated that the bran of wheat, in addition to the large per-centage of gluten, likewise contains a peculiar ferment, which possesses the property of rendering the flour or bread with which it is mixed more digestible.

It should be known also that the small or tail corn which is usually separated from the other corn, and used by the farmer himself, is richer in gluten than the large-sized grain.

The next table represents the mean composition of the ash of the chief cereal grains. It is taken from Pereira's "Materia Medica," and is drawn up from the calculated means contained in Johnston's "Lectures on Agricultural Chemistry and Geology," 2nd ed. 1847.

	Wheat.	Barley with Husk.	Oats.	Rye.	Indian Corn.	Rice.
Potash - - -	23·72	13·64	26·18	22·08	32·48	18·48
Soda - - -	9·05	8·14		11·67		10·67
Lime - - -	2·81	2·62	5·95	4·93	1·44	1·27
Magnesia - - -	12·03	7·46	9·95	10·35	16·22	11·69
Oxide of iron - -	0·67	1·48	0·40	1·36	0·30	0·45
Phosphoric acid - -	49·81	38·96	43·84	49·55	44·87	53·36
Sulphuric acid - -	0·24	0·10	10·45	0·98	2·77	—
Chlorine - - -	- -	0·04	0·26	- -	0·18	0·27
Silica - - -	1·17	27·10	2·67	0·43	1·44	3·35
Alumina - - -	- -	0·21	0·06	—	—	—
	99·50	99·72	99·76	101·35	99·70	99·54
Per-centage of ash -	about 2·0	2·84	2·18	2·425	about 1·5	1·00

Messrs. Ogston and Way give the following as the per-centages of silica in the ash of the ordinary cereal grains: 2·05 to 5·46 silica for wheat; from 23·6 to 70·77 for barley; from 38·48 to 50·03 for oats; and 9·22 for rye.

As we may sometimes require to determine the phosphoric acid present in the different corns, we append certain processes.

Dissolve the ash in as small a quantity of nitric acid as possible; add acetate of lead in slight excess; wash the precipitate, which consists of phosphate and basic nitrate of lead; dry, ignite, and weigh — the residue is phosphate of lead, plus oxide of lead; dissolve with heat in moderately dilute nitric acid, determine the oxide of lead as sulphate, calculate from this the oxide of lead, and deduct the result from the weight of the first residue; the difference gives the quantity of phosphoric acid.

If we desire to ascertain separately the amounts of alkaline and earthy phosphates, we proceed as follows: — The alkaline phosphates are dissolved out of the ash with water, and the phosphoric acid then precipitated by acetate of lead. The insoluble portion of the ash is treated with hydrochloric acid, and the analysis proceeded with as before.

Another method: —

Mix the acid solution containing the phosphoric acid with an excess of solution of sesquichloride of iron of known strength; add, if necessary, sufficient alkali to neutralise the greater portion of the free acid; mix with acetate of soda in excess, and boil. If the quantity of solution of sesquichloride of iron added was sufficient, the precipitate must be brownish-red. The precipitate consists of basic phosphate and basic acetate of sesquioxide of iron, and contains the whole of the phosphoric acid and of the sesquioxide of iron. Filter off boiling, wash with boiling water, dry carefully and ignite in a platinum crucible with access of air; moisten the residue, after its ignition, with strong nitric acid; evaporate this at a gentle heat, and ignite again. Should this operation have increased the weight, which is not the case usually, it must be repeated until the weight remains constant. Deduct from the weight of the residue that of the sesquioxide of iron contained in the solution added; the difference is the phosphoric acid.

ON THE DISEASES OF THE CEREAL GRASSES.

It not unfrequently happens that flour is greatly deteriorated, and in some instances rendered even positively injurious, through the attacks of various vegetable and animal productions. As flours thus diseased are sometimes referred to us under the impression that they are adulterated, it becomes necessary that we should be possessed of some information respecting the diseases of the cereal grasses.

The principal diseases arising from the attacks of fungi are Ergot, Smut or Dust, Brand, Rust, and Mildew.

ERGOT.

(*Oidium arbortifaciens.*)

Ergot is particularly prone to attack rye: it does not confine its ravages to that one grass, but has been observed to attack a variety of species; and amongst the rest, the ears of wheat.

The engraving on the next page represents a section of ergotised rye.

In flour contaminated with ergot the structures above delineated occur of course in a much broken and divided state.

Numerous and well attested instances are on record of dangerous and even fatal effects resulting from the consumption of bread containing ergot.

ON BUNT, SMUT BOLLS, OR PEPPER BRAND.

(*Uredo Caries*, Dec.; *Uredo fœtida*, Bauer.)

This fungus has hitherto been met with only in the grains of wheat; it is easily recognised by its disgusting smell. The spores or sporongia, analogous to seed vessels, are large and reticulated, as represented in the figure. Some doubt exists whether this fungus is deleterious or not; by many it is considered to be so. Flour containing it is frequently used for gingerbread. *Fig.* 88.

ON SMUT, OR DUST BRAND.

(*Uredo Segetum.*)

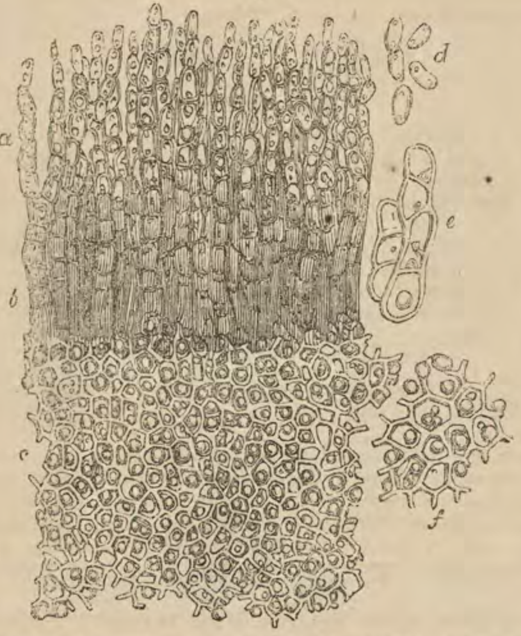
This fungus is comparatively rare in wheat, but very common in barley and oats; rye does not appear to be subject to it. It has not the disagreeable smell of the preceding species, and the spores are several times smaller. *Fig.* 89.

ON RUST, RED-RAG, RED-ROBIN, RED-GUM.

(*Uredo rubigo* and *Uredo linearis.*)

These so-called species are but young states of *Puccinia Graminis.* They form yellow, brown, oval spots or blotches upon the stem, leaf, and chaff; the sporules of which the blotches consist are intermediate in size between those of *Uredo caries* and *U. Segetum;* they are at first round, afterwards oval, and attached by a pellucid, short, and slender stalk to the surface on which they are developed, but after a time they become free.

Fig. 87.



This engraving represents a transverse section of Ergot of Rye. *a*. Terminal colourless filaments bearing the spores, which are seen on the extremities. *b*. The coloured threads which constitute the black or purple portion of the grain. *c*. The cells, with the contained spherules of oil, which form the body or colourless part of the grain, magnified 420 diameters. *d*, *e*, *f*, represent minute portions of the same structures, more highly magnified—viz., 670 diameters.

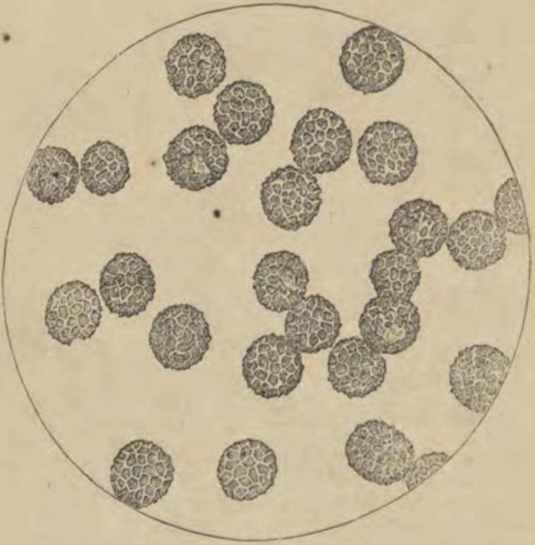
The engraving (*fig.* 90.) represents some wheat flour largely infested with *Puccinia Graminis* in the state formerly called *Uredo rubigo*. The sample, which was offered for sale, was brought to Dr. Muspratt, by whom it was forwarded to the author.

On Mildew.

(*Puccinia Graminis.*)

The ripe spores of this fungus are dark-brown club-shaped bodies, having the broader end divided into two compartments filled with sporules. "I have observed this fungus with the rust fungi in a way

Fig. 88.



This engraving represents the spores of UREDO CARIES, magnified 420 diameters. Drawing made from a preparation belonging to the late Dr. Pereira.

that strengthens my opinion that they are identical." — *Professor Henslow.*

In the engraving *fig*. 91. this fungus is represented in all the stages and conditions of its growth.

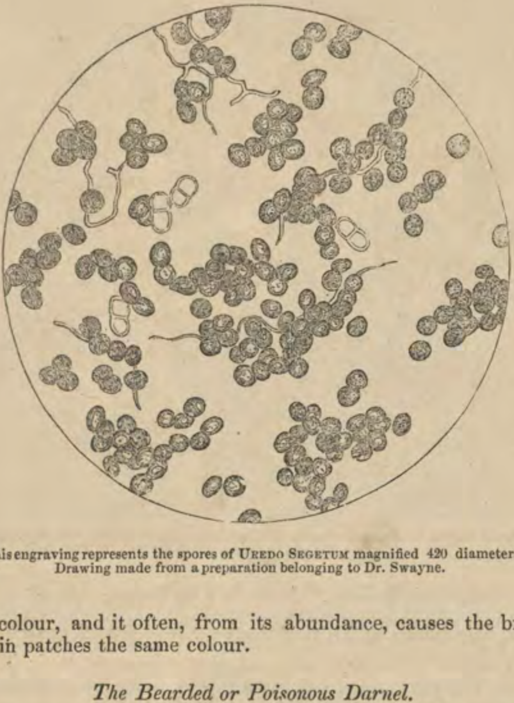
Penicilium glaucum, *Fermentum cirvisiæ*, *&c.*

When bread has been kept for a few days, and has become stale, certain species of fungi are apt to become developed in it. One of these is the well-known *Penicilium glaucum* which forms the green mould of cheese and other decaying organic substances: it is described and figured in a memoir by the author contained in the thirty-sixth volume of the "Medico-Chirurgical Transactions."

A second species is *Fermentum cirvisiæ*, or the yeast fungus, also described and figured in the memoir above alluded to. Its development in bread goes in part to show that the vitality of the yeast is not altogether destroyed by the baking of the bread.

A third fungus found in stale bread is very different from either of the others; it is represented in the engraving *fig.* 92. It is of a bright yellow colour, and it often, from its abundance, causes the bread to assume in patches the same colour.

Fig. 89.



This engraving represents the spores of UREDO SEGETUM magnified 420 diameters.
Drawing made from a preparation belonging to Dr. Swayne.

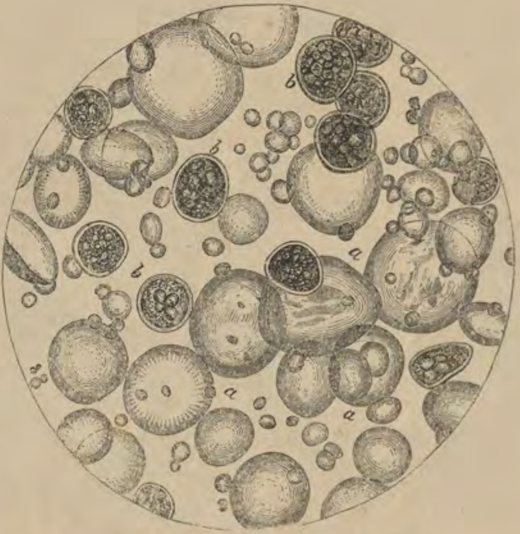
The Bearded or Poisonous Darnel.

The poisonous grass, *Lolium temulentum* or *darnel*, is by no means of uncommon occurrence, and numerous accidents have from time to time occurred, in consequence of its becoming mixed either with the flour of wheat, or some other cereal farina.

The effects of darnel on man are thus described by Pereira:—

"The ill effects of the seeds of bearded darnel on man were known to the ancient Greeks and Romans. The symptoms which they produce are twofold: those indicating gastro-intestinal irritation,—such as vomiting and colic; and those which arise from disorder of the cerebro-spinal system,—such as headache, giddiness, languor, ringing in the ears, confusion of sight, dilated pupil, delirium, heaviness, somnolency, trembling, convulsions, and paralysis. These seeds therefore appear

Fig. 90.



WHEAT FLOUR infested with *Puccinia Graminis*, in an early stage of development. 420 diameters.

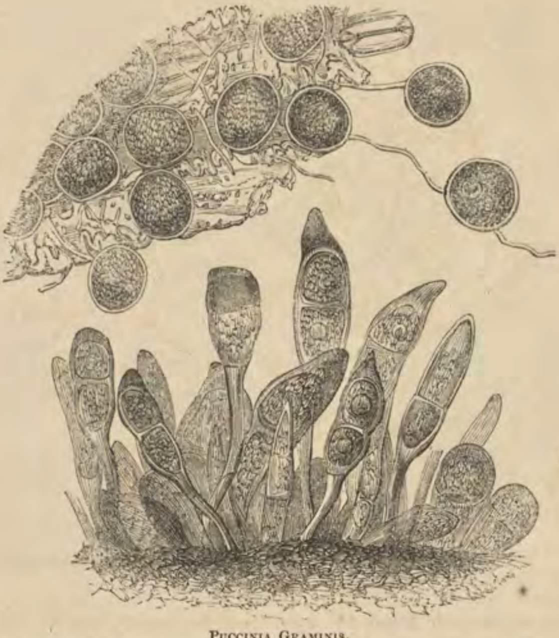
to be acro-narcotic poisons. According to Seeger, one of the most certain signs of poisoning by them is trembling of the whole body. Both Burghard and Schober (quoted by Wibmer) mention death as having resulted from their use. In Cordier's cases their ill effects were directly ascertained by experiments made upon himself; but in most other cases they were the result of accidental poisoning. In general they have arisen from the intermixture of bearded darnel seeds with other cereal grains. In a prison at Cologne, sixty persons suffered from the use of a bread meal, containing a drachm and a half of lolium temulentum in six ounces of meal."

As the chemical tests for darnel when mixed with flour are not very satisfactory or decisive, we have submitted the seeds to microscopical examination, and find them to be so different from those of wheat or rye, that when admixed with these in the state of flour they may be readily detected.

The starch corpuscles resemble very closely those of rice in form,—

that is, they are polygonal,—but they are much smaller, and, like those of the oat, they are frequently united into compound grains of various sizes, the larger grains consisting of some fifty or sixty starch corpuscles.

Fig. 91.

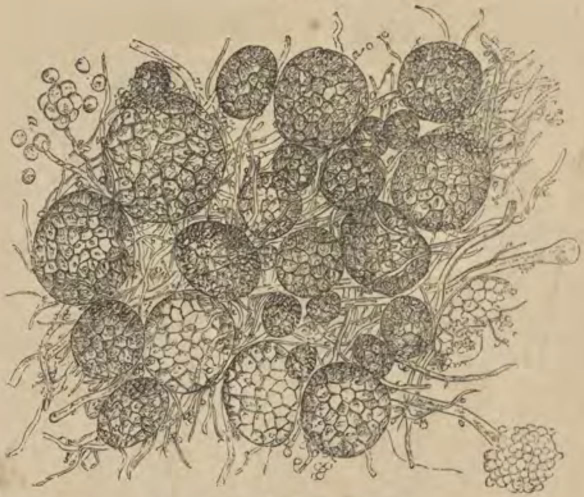


PUCCINIA GRAMINIS.
In all stages. Magnified 500 diameters. From specimens kindly furnished by the Rev. Prof. Henslow.

The structure of the *testa* is very different from that of either rice, the oat, or indeed any of the other cereal grains: it is formed of three coats or membranes; the cells of the *outer* coat form but a single layer, and, contrary to the arrangement which exists in the oat, their long axes are disposed transversely, in which respect they resemble rice: the fibres of the husk of rice and the cells of the testa of lolium are, however, very distinct in other respects. In the former the cells are long and narrow, forming fibres, while in the latter they are but between two and three times as long and broad.

The cells of the *second* coat, which are ranged in two layers, follow a vertical disposition,—an arrangement which is contrary to that which obtains in all the other cereal grains with the exception of rice.

Fig. 92.



Fungus, commonly found in *stale* Bread.

The cells of the *third* coat form but a single layer, and resemble those of the other grains described.

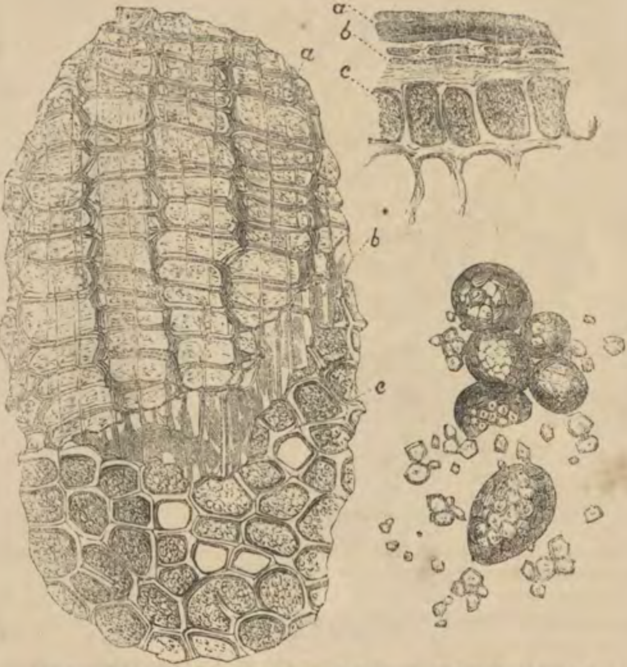
We have now to consider the diseases of corn produced not by the invasion of parasitic fungi, but animal productions.

On Ear Cockle, Purples, or Peppercorn.

(*Vibrio Tritici.*)

The grains affected turn green at first, and ultimately black; they become rounded, resembling a small peppercorn; the husks are spread out and the awns twisted, by which means the infected ears are readily observable amongst the standing corn. The blighted grains are filled with a moist cotton-like substance and contain no flour. This substance is composed of myriads of eel-shaped animalcules, which, as soon as moistened with water, exhibit the most active movements. A most extraordinary circumstance connected with these animalcules is, that they may be so perfectly dried that on the slightest touch they break up into powder, and yet, when moistened, they will revive and become as active as at first. This operation may even be repeated several times before the vitality of the animalcules is finally destroyed.

Fig. 93.



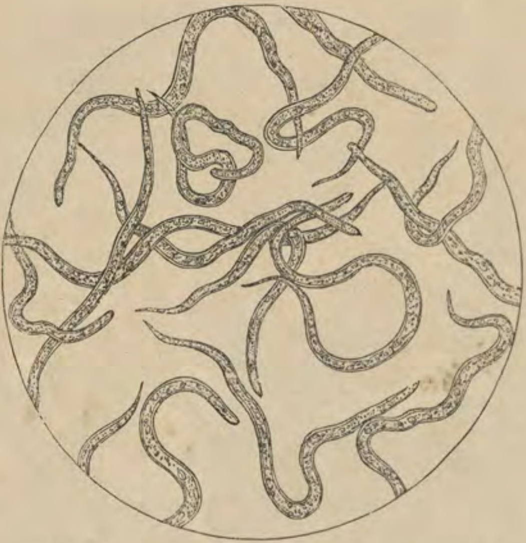
Structure of the grain of LOLIUM TEMULENTUM, or *Darnel*. Showing transverse and vertical sections of testa, magnified 200 diameters; also the characters of the starch corpuscles, magnified 500 diameters.

ON THE WHEAT MIDGE.

(*Cecidomyia Tritici.*)

This is a two-winged fly, which may be seen in myriads in the early part of June, in the evenings from seven to nine o'clock, flying about the wheat for the purpose of depositing its eggs within the blossoms: the eggs become hatched into yellow maggots or caterpillars, and by these the mischief is occasioned; they cause the non-development of the ovary, so that the grain never advances beyond its condition at the time the flower first expands. All the grains in an ear are not usually affected, but only grains here and there. A figure of the fly and its caterpillar will be found in the "Transactions of the Linnæan Society."

Fig. 94.



Numerous **Vibriones Tritici**, magnified 100 diameters. Drawing made from preparation belonging to the late Dr. Pereira.

Acarus Farinæ.

This mite is never present in flour unless this has become damaged. It differs considerably in structure from the sugar mite. *Fig.* 95.

Another species of acarus, met with on one occasion in wheat flour, is exhibited in the engraving, *fig.* 96.

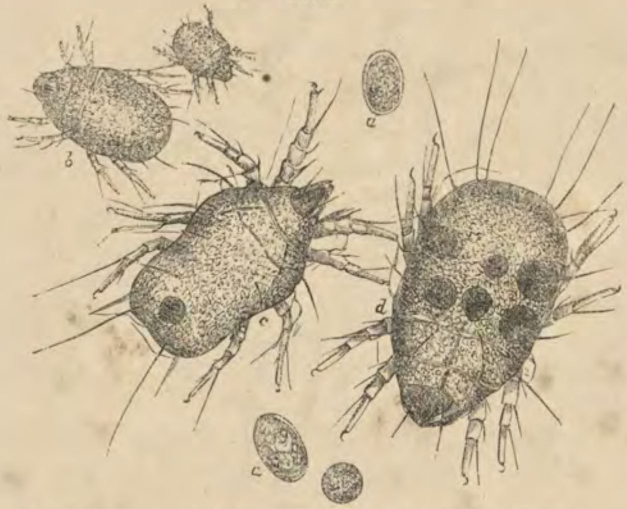
ON THE MANUFACTURE OF BREAD.

Two kinds of bread are manufactured—the one is made with yeast, ferment, or leaven, and is hence called leavened; the other is prepared without leaven, and is denominated unleavened; the operation of the substances used in the manufacture of this description of bread, are, to a certain extent, analogous to that of yeast.

Leavened or Fermented Bread.

Leavened bread should consist only of flour, yeast, and water, with a little salt; such is the composition of genuine *home-made bread*, the flavour of which is so agreeable, and so very different from that of ordinary bakers' bread.

Fig. 95.



Acarus Farinæ, or *meal mite*, from the ovum to the mature state, from *wheat flour*. *a a*, *ova*; *b b*, *young*; *c*, *male*; *d*, *female*. Magnified 75 diameters.

In the preparation of the bread of the shops, flour of inferior quality is frequently used, and this is mixed up with large quantities of salt, potatoes, sometimes rice, and other flours, and alum; these substances impart to it a taste very distinct from that of home-made bread, and occasion much of the difference observed between that description of bread and ordinary bakers' bread.

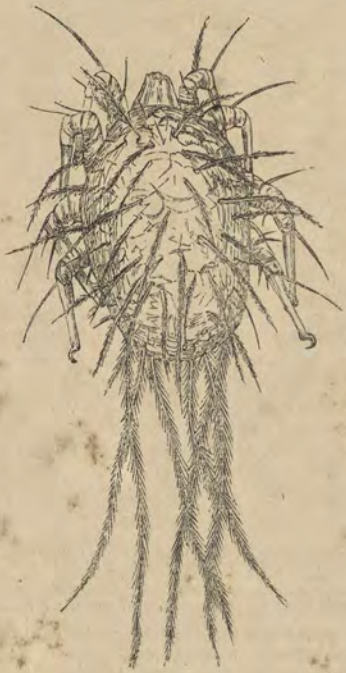
Yeast, or the Yeast Plant.

The substance known as yeast is in reality a plant, belonging to the tribe of *Fungi*; it consists of a multitude of minute oval or circular bodies or sporules, endowed, under certain favourable circumstances, with extraordinary powers of growth and multiplication.

Three kinds of yeast are employed in the manufacture of bread —

viz., brewers' yeast, German yeast, and patent yeast. Some bakers use one, and some another, but the greater number make use of

Fig. 96.



ACARUS from Flour. Drawn with the Camera Lucida, and magnified 220 diameters.

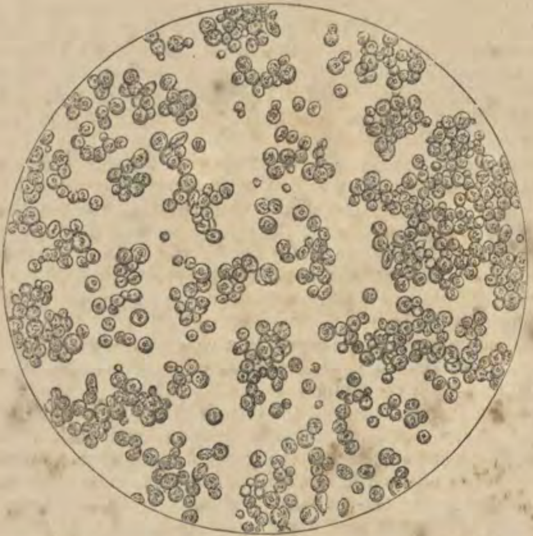
patent yeast, on account of its cheapness. The fungus is of the same species in each.

Brewers' Yeast.—This, as is well known, is of a light brown or fawn colour, and of a frothy consistence; when recent, it is in constant movement, and bubbles of gas escape from it.

Examined with the microscope, it is seen to consist of innumerable minute bodies, termed sporules, of variable size, some circular, and others oval, and all intermingled with very many globules of carbonic acid gas. These sporules multiply rapidly when the yeast is in an active condition.

Brewers and bakers "distinguish yeast according to the quality of the beer from which it is obtained. *Ale yeast* is the best and strongest, and is used for bread making. *Porter yeast* is objected to by bakers, but is used in distilleries. *Small beer yeast* is said to be weak, but rapid in its effects, and is sometimes used in making rolls."—*Pereira.*

Fig. 97.



This engraving represents "THE YEAST FUNGUS" in the first stage of its development, or that of sporules. As generally met with, and as used in the fermentation of bread, yeast consists of an immense number of similar sporules intermixed with bubbles of carbonic acid. Drawn with the Camera Lucida, and magnified 220 diameters.

German Yeast.—This, which is sometimes called "*dried yeast,*" consists of sporules only, with but little adherent moisture, and no gas. It forms a paste-like substance, and is obtained from a fermented liquid by filtration. It is imported into this country principally from Germany, in hempen bags, each holding half a hundredweight. When placed in casks, it is apt to burst them, in consequence of the carbonic acid sometimes evolved.

We believe that this yeast is perfectly wholesome, and that no foundation exists for the reports, recently set on foot, as to its possessing injurious properties or qualities of any kind.

Patent Yeast.—This is prepared from an infusion of malt and hops.

It is a thin watery liquid, containing innumerable sporules of the yeast plant in suspension. The hops are added to prevent the liquid from becoming rapidly sour.

This mode of preparation of patent yeast is considerably varied by different bakers. Many add a portion of brewers' or German yeast to an infusion containing either flour or malt, with potatoes. These substances supply the food or nourishment upon which the yeast cells grow, and multiply with much rapidity, as well as the material for conversion into carbonic acid. Yeast cells, in the course of a few days, make their appearance in a simple infusion of malt, and occasionally even of flour.

Patent yeast, before being mixed with the flour, is sometimes allowed to drain through a copper basin or sieve perforated with numerous holes; by this means the chief part of the mashed potato employed in the preparation of the yeast is separated.

Discovery of the Development of the Yeast Plant.—Few productions have created more interest or excited greater discussion than yeast; its nature and the mode of its operation have been made subjects of keen inquiry and dispute.

These points are now, however, to a very great extent, set at rest; its fungoid character is generally admitted, and its *modus operandi* in panification is well understood.

In one particular, however, the history of the yeast plant was, until very recently, incomplete; this related to its development.

Most observers admit that the yeast fungus, as met with in the different forms of yeast in use, is in an imperfect state of development, and frequent attempts—the most notable being those of Turpin—have been made to discover the perfect plant or fungus. All their efforts, however, up to a recent period, failed. More fortunate than our predecessors, we have succeeded in tracing the yeast plant through all the stages of its growth to its perfect state, that of a fungus with distinct aerial fructification. For a full account of the development and structure of the yeast fungus, the reader is referred to "Food and its Adulterations," p. 152.; and to a paper by the author, in the thirty-sixth volume of the "Medico-Chirurgical Transactions," p. 26.

Modus Operandi of Yeast.

The presence of yeast in a substance containing sugar or starch which is convertible into sugar, and nitrogenised matter, induces certain chemical changes, comprehended under the term vinous or alcoholic fermentation.

These changes in the making of bread consist in the conversion of the sugar of the flour into *alcohol* and *carbonic acid gas;* the latter, in its efforts to escape from the dough with which it is mixed, distends it, forming vesicular spaces in its interior, and so causing it to become porous and light. The alcohol entirely escapes from the loaf.

A minute portion of the starch is converted, by the agency of the yeast, into *sugar*, which, in its turn, is changed into alcohol and carbonic acid. If we examine attentively with the microscope the starch corpuscles contained in fermented and baked bread, we observe that they are still entire, although altered somewhat in form.

During the baking, part of the starch is undoubtedly converted into *gum*.

Some physicians are of opinion that the presence of yeast imparts injurious properties to leavened bread. This point is one of great practical importance; but so far as we are aware, no complete or conclusive observations have yet been made on the subject.

It has been computed that the annual loss of alcohol in bread making amounts to about 300,000 gallons, which, at 19*s*. per gallon, would amount to 285,000*l*. The efforts hitherto made in large bakeries to save the alcohol have failed: 20,000*l*. were spent in the fruitless endeavour to collect and condense the alcohol in the military bakery at Chelsea.

Unleavened or Unfermented Bread.

There are two kinds of unfermented bread; in the one, substances are used in imitation of yeast, from which a gas, always the carbonic, is disengaged, distending the dough, and rendering it vesicular and light; in the other, flour, water, with perhaps the addition of salt, only are employed.

The substances used in the preparation of the first description of unfermented bread are sesquicarbonate of ammonia, carbonate of soda and hydrochloric acid, or carbonate of soda and tartaric acid.

Of these, by far the best is carbonate of ammonia: this is a volatile salt, and its great advantage is, that it is entirely or almost entirely dissipated by the heat employed in the preparation of the bread; and thus the necessary effect is produced without much possibility of injurious results ensuing.

In the employment of carbonate of soda and hydrochloric or muriatic acid, the case is, however, different; here we have the formation of chloride of sodium, or common salt, with disengagement of carbonic acid.

In those instances where a mixture of carbonate of soda and tartaric acid are used, a tartrate of soda is formed, also with liberation of carbonic acid.

The preparations known as *Baking*, *Egg*, and *Custard powders* are combinations of carbonate of soda and tartaric acid, mixed with wheat flour, or other kinds of starch, and the egg powders are often coloured with either *turmeric* or *chromate of lead*.

It is extremely doubtful how far these preparations may be used with safety to the public health; for our own part, we see much less objection to the employment, in the generality of cases, of a substance like yeast, which contains but little saline matter, and the vitality of which is for the most part destroyed by the heat of the oven, than in the use of acids and alkalies, of egg and baking powders.

A sample of "Borwick's Baking Powder" examined by us we found composed of an acid and an alkali—tartaric acid, and either carbonate of potash or soda, together with ground rice, a small quantity of wheat flour, and perhaps a little sugar. According to a plan commonly employed some time since, the liberation of the carbonic acid gas was effected by means of hydrochloric acid added to the dough containing the alkali; in this case a chloride of sodium or common salt was formed instead of tartrate of soda or potash, as in the present instance. Now it should be remembered that hydrochloric acid is frequently contaminated to a serious extent with *arsenic.* The action of this and other analogous powders in lightening or leavening bread, like that of yeast, is dependent, as already remarked, upon the slow extrication of carbonic acid gas, which, becoming diffused throughout the dough, forms the little cavities noticeable in white bread, and which render it porous and spongy. In the case of baking powder containing tartaric acid, as soon as the flour throughout which the powder has been diffused is moistened with water, the tartaric acid unites with the soda or potash, forming a tartrate of one or other of these bases, either of which salts possesses diuretic and aperient properties. It is on this account that bread made with these powders, while it may prove of service in some cases of dyspepsia, in others is calculated to do harm.

The water we drink is largely impregnated with a host of saline ingredients; the bread we eat is saturated with alum and "stuff;" and it behoves us to be careful how we add to the large amount of saline matter daily ingested.

That these observations are not misplaced or over-strained will appear from the following published receipts for the preparation of unfermented bread:—

To make White or Flour Bread.

Flour dressed or household	- -	3 lb. avoirdupoise.
Bicarbonate of soda, in powder	-	9 drachms, Apothecaries' weight.
Hydrochloric (muriatic) acid	- -	11¼ fluid drachms.
Water - - - -	about	25 fluid ounces.

Observe the large quantity of soda and acid recommended to be employed in the manufacture of a 3lb. loaf; and remember that it is no easy matter either to blend equally the ingredients, or exactly to add them in neutralising proportions.

Dr. Pereira gave the following receipt for the manufacture of unfermented bread; the proportions of soda and acid in this are much less:—

Receipt for Unfermented Bread.

Flour - - - -	1 lb.
Bicarbonate of soda - -	40 grains.
Cold water - - -	½ a pint.
Muriatic acid - - -	50 drops.

Receipt for an Egg or Baking Powder.

Carbonate of soda - - -	56 lbs.
Tartaric acid - - -	28 lbs.
Potato flour - - -	1 cwt.
Turmeric powder - - -	¾ lb.

It will be observed that the quantity of tartaric acid in this receipt is much too small to neutralise the soda. It is better adapted for pudding than bread.

The second description of unfermented bread is heavy and compact, and is met with chiefly in the form of biscuits.

On the Adulterations of Flour and Bread.

Adulteration of Flour.—The adulterations practised upon bread, are often effected through the medium of the Flour from which it is made: it will therefore be proper, before proceeding to describe the adulterations of bread, to notice those to which flour is subjected.

The substances employed in the adulteration of flour, include many of those which have been met with in bread itself.

One adulteration of flour is with *bean meal.* It is a common practice for millers to add bean meal to flour; and it is said that this addition is not made so much for the sake of profit, as to render certain descriptions of flour more tenacious when made into dough, bean meal effecting this object, in consequence of the large quantity of nitrogenous matter which it contains. In the case of genuine wheat flour of good quality, no such addition is required; when the flour is damaged, beans are used in considerable quantities.

Another addition sometimes made is *rice flour.* The purpose served by the addition of this article, unless it be exclusively for the sake of adulteration, is not apparent, since it does not cause bread to bind better. It causes it indeed to hold more water, and possibly has some effect in whitening it.

Again, in some cases, *barley, rye, Indian corn,* and *potato* flours have been added to wheat flour.

According to the evidence of Mr. Emerson, the manager of "The People's Flour Mill" at Leeds, as given before the Parliamentary Committee on Adulteration, wheat flour is frequently adulterated with about twenty-five per cent. of *barley flour*, which is not much more than half the price of wheat flour.

The following very curious evidence, in regard to the adulteration of wheat flour, was given before the Committee by Mr. Potto Brown, a miller of forty years' standing, and whose business lies chiefly in London.

"Barley is mixed with wheat in some districts to cheapen the price. In other districts wheat is mixed with barley to improve the quality, particularly in Northamptonshire. The poor people consider barley more nutritious than wheat flour. I do not know that that is the case; I am doubtful of the point, but it is the universal opinion of the poor people."

Again: "To give the above qualities to my flour, I add one part of bean flour to sixty parts of wheat meal; never more than one in forty."

"White *peas* improve the appearance of flour, but not the quality, and are put in to cheapen it."

Sir J. Gordon, mayor of Cork, furnished the Committee with the following evidence in regard to the use of Dari:—

"There is an Egyptian grain called Dari, that was imported in very large quantities at one time into Cork; that to a moral certainty was for the purpose of mixing with wheaten flour: they were able to sell that for 6*l.* a ton, while the other was bringing nearly three times that amount."

Large quantities of damaged wheat flour are also annually sold: this is usually more adulterated than any other flour, in a variety of ways, to render it saleable; as by admixture with other flours, with alum, and carbonate of soda. The object of the admixtures of alum and soda is to harden the partially decomposed gluten, and to correct the acidity resulting from decomposition.

Another substance frequently added to flour, is *alum*. This is done to whiten the flour, and to cause the bread made from it to appear white. This addition, like the majority of the other adulterations of flour, is practised by millers. It is only a few weeks since, that a miller residing at Bromsgrove was fined for adulterating his flour with alum; this miller had no less than 600 lbs. of that substance on his premises at the time of the discovery.

A substance called *mineral white*, which is a hydrated sulphate of lime, is occasionally added to flour. Several millers have within the last few months been convicted for putting this substance into flour. One of these cases occurred near Heaton Norris.

Convictions have also recently taken place for using silicate of *alumina*, other names for which are *China clay* and *Cornish clay*.

A variety of other substances, it has been alleged, have been and are used for the adulteration of flour; and it is most probable that the majority of them have been thus employed, although we are not ourselves acquainted with any recent cases of their detection in flour. To some of these substances we shall shortly refer when noticing the adulterations of bread.

On the Adulterations of Cones Flour.

There is an article in common and daily use by bakers, denominated "*Cones*" or "*Cones Flour.*" With the existence of this article until recently we were unacquainted, nor is reference once made to it by any of the many witnesses — millers, bakers, &c.— in the evidence given before the Parliamentary Committee. Our attention became directed to it in consequence of the following circumstance:

Dr. Paley, of Peterborough, brought the author a sample of flour for examination, seized on suspicion, and which he stated the baker called "Cones Flour." On subjecting this to microscopical examination, it was found that it consisted entirely of rice flour.

This induced him to make further inquiries: he soon learned that genuine Cones flour consists of the flour of a particular species of wheat called *Revet.*

Further, that it was employed by bakers to dust the dough, as well as the boards upon which this is made into loaves, the object of its use being to prevent the dough either adhering to the boards, or the loaves to each other, in the course of baking.

Having learned thus much, the author procured from bakers numerous samples of Cones, and subjected them to examination; the results are exhibited in the annexed list. The names of the parties of whom they were obtained are not given, because many of them were procured indirectly, and in some cases through the instrumentality of friends, Cones flour being an article which cannot be purchased by the public in the ordinary way.

Results of the Microscopical Examination of Twenty-two samples of Cones flour, procured chiefly in the metropolis in the autumn of 1856: —

1st Sample.

Adulterated. Contains *Rye* and *Rice* flours.

2nd Sample.

Not Cones flour at all. Consists entirely of *Rice* flour.

3rd Sample.

Adulterated. Contains *Rice* flour.

4th Sample.

Adulterated. Contains *Rice* flour.

5th Sample.

Adulterated. Consists in great part of *Rice* flour.

6th Sample.

Genuine.

7th Sample.

Adulterated. Consists almost entirely of *Rice* flour.

8th Sample.

Adulterated. Composed almost entirely of *Rice* flour.

9th Sample.

Adulterated. Consisting chiefly of *Rice* and *Bean* flours.

10th Sample.

Adulterated. Contains much *Rice* flour.

11th Sample.

Not Cones at all. Consists of *Rice*, *Indian Corn*, and *Bean* flours.

12th Sample.

Adulterated. Consists in great part of *Bean* and *Rice* flours.

13th Sample.

Adulterated. Contains much *Rice* flour.

14th Sample.

Adulterated. Contains *Barley* flour and *alum.*

15th Sample.

Genuine.

16th Sample.

Adulterated. Admixed with both *Barley* and *Rice* flours.

17th Sample.

Adulterated. Consisting in great part of *Rice* flour.

18th Sample.

Genuine.

19th Sample.

Genuine.

20th Sample.

Genuine.

21st Sample.

Not Cones at all. Consisting entirely of *Rice* and *Indian Corn* flours.

22nd Sample.

Adulterated. Consisting chiefly of *Rice*, with some *Indian Corn* flour, and much *Salt.*

It appears, therefore, that *Cones flour is rarely to be obtained genuine, but is subject to an enormous amount of adulteration*, this usually consisting in the addition of very large quantities of *rice*, *rye*, *barley*, *bean*, and *Indian corn* flours, and sometimes of *salt* and *alum*. Further, that some of the samples do *not contain a particle of wheat flour*, of which alone they should consist.

The object of these additions is obviously to cheapen the article; and that this purpose is effected sometimes to the extent of nearly one half might be readily proved by quoting the several market prices of the different varieties of grain above referred to.

That this is really so may be shown in another way: several qualities of Cones flour are sold, the best being nearly twice the price of the worst, and the adulteration being usually in proportion to the price.

Two questions now present themselves for consideration in connection with Cones flour: the first is, whether any real necessity exists for the use of even genuine, much less adulterated Cones flour; and the second is, whether this flour, especially when adulterated, as it usually is, is ever applied to any other purpose than that avowed.

The first question is almost sufficiently answered by the fact that some do not use Cones flour at all, and yet do not experience any great difficulty in the manufacture of the bread; there is therefore good reason for believing that price has very much to do with the general employment of Cones flour, even in those cases in which it is really used to prevent the adhesion of the loaves.

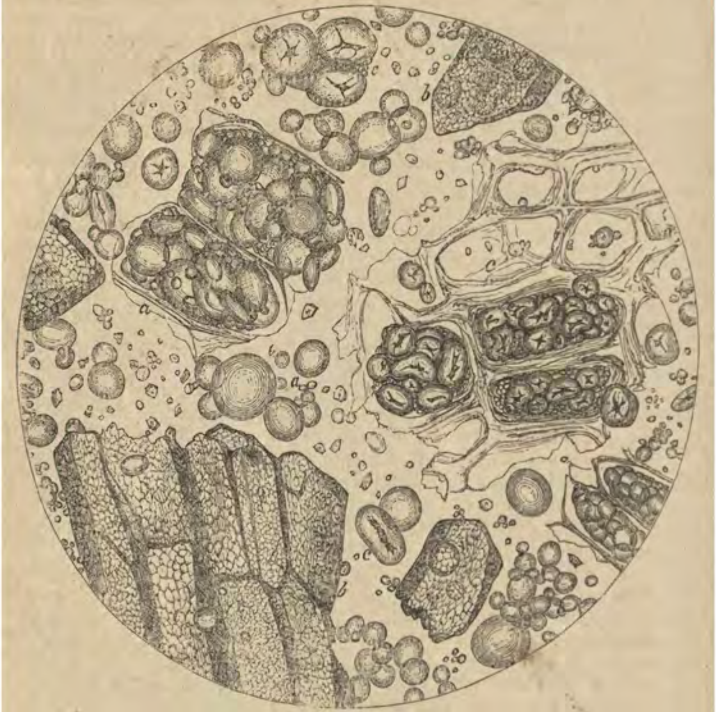
With regard to the second question, there can be no doubt but that Cones flour is frequently employed in the adulteration of bread: this is shown in some cases by the character of certain of the adulterations to which it is subject, namely those by admixture with bean flour, alum, and salt; now bean flour is actually of a more glutinous and adhering nature than pure wheat flour of good quality itself, and therefore its presence tends to unfit it for the very purpose for which it is alleged that it is designed.

But some bakers have even acknowledged to the employment of Cones flour for purposes of adulteration, for which, from its composition, especially when adulterated, as it so constantly is, it is so well suited.

Supposing, however, the Cones flour to be employed for dusting the dough, and that this is a legitimate use, still this does not justify its adulteration.

In the article Cones flour prepared by millers, bakers, then, are furnished with a material avowedly wheat flour, but which, consisting of mixtures of different and cheaper flours, is in every way suited for the adulteration of bread; and that it is extensively used for this

Fig. 98.



Adulterated CONES FLOUR, consisting of a mixture of *wheat*, *rice*, and *bean* flours.
Magnified 225 diameters.

purpose cannot be doubted. The system adopted by millers, of supplying under the name of Cones flour and as wheat flour, compounds adapted for adulteration, is surely very cunningly devised. The public know nothing of this article, the master bakers themselves are ignorant of its exact composition; while the journeyman, in most cases, when he adds, by his master's directions, a bushel of Cones to a sack of flour, has no idea that he is adulterating the bread.

The case of Cones flour affords another example of what the microscope is capable of effecting in connection with the subject of adulteration. Had it not been for that instrument it would have been utterly impossible to have ascertained by scientific means the composition of the heterogeneous mixture called Cones flour.

The admirable engraving *fig.* 98. exhibits the characters presented by a sample of so-called Cones flour, composed of wheat, rice, and bean flours. It is difficult to determine which is the most excellent, the drawing of Mr. Tuffen West or the engraving of Mr. Hart.

On the Adulterations of Bread.

Well then, flour containing any of the articles already mentioned, the BREAD made from it must of course do so likewise; but other and further adulterations of bread are practised by bakers.

It is notorious that the great majority of bakers add either *alum* to their bread or a mixture of alum and salt known in the trade by the terms "hards" and "stuff;" and thus in many cases the flour receives two additions of alum, the baker being often unaware that he has been already anticipated by the miller.

It is also notorious that bakers frequently add a proportion of *potatoes* to bread. These, when mashed, are mixed with the yeast, which is said to feed upon the potatoes, and for which purpose only it is alleged the potatoes are used, and not for adulteration. When the quantity of potatoes employed is but small, this may be so; but there is no doubt that potatoes are sometimes added in considerable quantities to bread, especially when they are cheap.

The injury to the properties of the bread by its adulteration with the flours and vegetable substances referred to, especially rice and potatoes, is very great, as can be readily proved.

Wheaten flour owes its superiority over nearly all other kinds of flour to the large amount of gluten which it contains, and which is the constituent that gives value to it and upon which its nutritious properties depend: this amounts in ordinary flour to not less than 12 per cent. Now, rice and potatoes, both so commonly added to bread, contain not more than 7 per cent. of that substance,—that is, they are but little more than half as nutritious as good wheat flour,—and consequently any bread to which these articles are added is robbed of much of its nourishment.

But the evil does not end here; the rice and some other substances swell up, and absorb, when made into bread, a much larger quantity of water than wheat flour, and thus the quality of the bread as a life-sustaining food is still further reduced.

The use of *alum* in bread—and it is almost always used by bakers—*is particularly injurious*. It is true it causes the bread to be whiter than it would be otherwise, indeed whiter than it was ever intended to be by Nature; but it imparts to bread several other properties: thus it hardens the nutritious constituent of the bread, the gluten, and so (on the authority of that great chemist Liebig) renders the bread more indigestible; it enables the baker to adulterate his bread with greater quantities of rice and potatoes than he could otherwise employ; and, lastly, by the use of alum he is able to pass off an inferior, and even a damaged flour, for one of superior quality. Is it then worth while, or rather is it not very foolish, thus to injure the properties of the bread by using alum for the mere sake of obtaining an unnaturally white loaf?

The public, then, in judging of the quality of bread by its colour,—by its whiteness,—commits a most serious mistake: there is little or no connection between colour and quality; in fact, very generally, the whitest breads are the most adulterated. The public, therefore, should lose no time in correcting its judgment on this point.

Again, the mistaken taste of the public for very white bread—which, be it known, cannot be obtained even from the finest and best flour except by the use of alum or some other substance similar in its operation—tends to the serious injury of the bread in another way.

The outer part of the grains of wheat has been proved by analysis to be much richer in nourishing principles, in gluten and in oily matter especially, than the central and more floury parts of the grain. Now, in preparing the finer descriptions of flour, the utmost pains are taken to separate this highly nutritious exterior portion of the grain, and thus, although the flour so obtained is very fine and white,—very suitable for making a white loaf, that fallacious test of quality,—it is yet not nearly so nutritious as whole meal flour, or even the less finely dressed qualities of wheat flour. The consumer, now better instructed, is in a position to judge of how much he sacrifices for the mere sake of an arbitrary and fallacious standard of quality, namely whiteness. The difference in nourishing properties between whole meal flour and very finely-dressed flour amounts in many cases to fully one third.

Further, alum is very apt to disorder the stomach, and to occasion acidity and dyspepsia.

The manner in which it does so has not been clearly ascertained. The powerful effects of alum as an astringent, when administered as a medicine, are well known; but it is considered by Mr. Lewis Thompson that, when added to flour or bread, it becomes decomposed by the gluten, a bisulphate of potash being formed. Whether this view is correct or not, is questionable, and it is entirely opposed to the opinions and statements of Liebig.

Mr. Lewis, in his evidence before the Parliamentary Committee, does not advance a single *proof* in support of his views.

Liebig considers that part of the beneficial action of wheat flour on the system is due to the soluble phosphates which it contains in such large quantities, and he states that when alum is added to bread these are decomposed, the phosphoric acid of the phosphates uniting with the alumina of the alum, and that thus an insoluble phosphate of alumina is formed, and the beneficial action of the phosphates consequently lost to the system.

So satisfied is Liebig that this is the case, that for some years past he has recommended the employment of small quantities of lime water for the purpose of whitening bread made from musty or damaged flour; and it was stated at the recent meeting of the British Association at Glasgow, that lime water is now used by many Scotch bakers.

The following is Liebig's own statement of his views: —

" Many salts render the gluten again insoluble, apparently by forming with it a chemical combination.

" The bakers of Belgium discovered, about twenty years ago, how to bake from damaged flour—by adding sulphate of copper (a poison) to the dough—a bread in appearance and external properties as fine as from the best wheat flour. This mode of improving its physical properties of course deteriorates its chemical properties. Alum has the same effect as sulphate of copper: when added to the dough it renders the bread very light, elastic, firm, and dry; and the London bakers in consequence of the demand for white bread, such as the English and American flour, usually so good, yields, appear to have been compelled to add alum to all flour in the baking. I saw in an alum manufactory in Scotland, little mounds of finely ground alum, which was destined for the use of the London bakers.

" Since phosphoric acid forms with alumina a compound hardly decomposable by alkalies or acids, this may perhaps explain the indigestibility of the London bakers' bread, which strikes all foreigners. A small quantity of lime water added to the musty or damaged flour, has the same effect as the alum or sulphate of copper, without being followed by the same disadvantages."—*Letters on Chemistry.*

Supposing for a moment Mr. Thompson's views to be correct, it has still to be proved that bisulphate of potash constitutes a wholesome ingredient in bread. Mr. Thompson states of it himself, in the evidence referred to, that "it is a singularly sour thing;" if so, it is surely the occasion of much of the acidity resulting from the use of bread to which alum has been added.

Enough has now been adduced to show that, whether the views alluded to are correct or not, it is a very dangerous thing to tamper with articles of daily food and of large consumption, like flour and bread, by the addition of chemical substances of any kind.

It is curious to notice the arguments to which the defenders of adulteration are driven in order to find excuses for certain practices. We were recently much astonished at one of these arguments.

A learned chemical professor, at the late meeting of the British Association in Glasgow, defended the use of alum in bread on the following ground: —

He stated that Thames water was so alkaline it turned the flour *yellow*, and hence the use of an acid became necessary.

Home-made bread is certainly not so white as bakers' bread, the difference being explained by the absence of the alum; but it is certainly not the case that Thames water has the remarkable effect of turning the flour yellow.

But the real and actual facts, as regards Thames water and its effects on the colour of the bread, are these: —

The alkalinity of Thames water is so trifling that it is scarcely perceptible to the most delicate test paper: again, during the fermentation of the bread a large quantity of acid is generated, infinitely more than would be sufficient to neutralise the alleged alkalinity of Thames water, and to counteract any tendency which it is said to possess to turn flour yellow.

Again, contrast the professor's *argument* with the *practice* recommended by Baron Liebig. The one says Thames water is so alkaline it turns flour yellow, and the other advises the use of an alkali to whiten it.

But we will suppose that the professor's views are not altogether destitute of foundation, yet they would constitute but a poor reason for the employment of alum. That substance is used in bread-making nearly all over the United Kingdom, and yet the use of Thames water is confined to the Metropolis and its vicinity. We repeat, then, it is curious to notice the character of the arguments which sometimes even scientific men will condescend to use in defence of adulteration.

Another argument by which the use of alum is defended, is that the quantity employed is but small: upon this point the following evidence may be adduced: —

The author of the celebrated treatise "Death in the Pot," writes: — "The smallest quantity of alum which can be employed with effect to produce a white, light, and porous bread from an inferior kind of flour, I have my own baker's authority to state, is from three to four ounces of alum to a sack of flour weighing 240 lbs."

Dr. Markham gives 8 ounces of alum as the quantity used to a sack of flour.

From inquiries which we have made amongst bakers, we find that the quantity of alum usually employed is half a pound to the sack of flour weighing 240 lbs., and that the quantity used varies according to the age and condition of the flour: thus new flour requires much more alum than old; indeed, a white bread may be made from old flour without any addition of alum, while as much as three quarters of a pound may be added to the sack of very new flour. New flour is that which comes into use about November and December; hence the bread made in these months usually contains a large proportion of alum. Old flour is that used in the two or three summer months preceding the harvest.

Four ounces gives about 30 grains of alum to every 4 lbs. of flour, eight ounces 60 grains, and twelve ounces 90 grains. Mr. Mitchell, the author of a treatise on the "Falsification of Food," states, that he detected in ten 4 pound loaves of bread, 819½ grains of alum.

With respect to condition, a flour which is weak—that is, which does not bind readily in consequence of a deficiency of gluten—requires a much larger proportion of alum, and in this case from three-quarters to a pound of that salt may be added.

Salt has much the same effect as alum; that is, it makes the bread white and firm, and hence it is sometimes used in excess, to supply the place, to some extent, of alum. The average quantity of salt added by bakers to bread wherein alum is used is not about sixty ounces to the 240 lbs.; but the amount varies with the age of the flour.

The use of alum in bread is prohibited by law, under certain pecuniary penalties; this law is, however, rarely enforced. We gather, however, from the existence of such a law, that the legislature considers the use of alum in bread to be objectionable.

The use of another mineral substance, carbonate of magnesia, has even been specially recommended by Mr. C. Davy, on the ground that it improves the colour of new and inferior flour, and increases the yield,—neither of which results, so far as the public is concerned, are in the least desirable. The increased yield simply signifies *more water.* The quantity of magnesia required varies from 20 to 40 grains to a pound of flour.

We have already referred, to some extent, to *the adulteration of bread with water.* Bread naturally contains a large quantity of water, estimated at 66 parts in every 150 of bread—16 of these only being natural to the flour, but it is frequently made to contain greater amounts: one principal means by which this is effected, is by the addition of rice or rice flour to bread; this, swelling up, absorbs much more water than wheat flour. Potatoes used in any quantity, probably have, to some extent, the same effect. In the introduction of rice, then, into bread, there is a double evil: first, a substance is put into the bread, which does not possess nearly so much nourishment as wheat flour; and second, by its means a larger quantity of another substance is absorbed by the bread, and which really has no nourishing properties whatever. While wheat flour seldom contains less, and often much more, than 12 per cent. of gluten, rice has only about 7 per cent. of that nutritious substance, and potatoes are equally deficient in gluten.

Another way to increase the quantity of water in bread, is, after having incorporated as much water in the dough as possible, to put it in a hot oven: this causes the crust to form speedily, and thus the escape of the water is prevented.

Lastly, the same object is in a measure attained by throwing sacks over the loaves when removed from the oven: this prevents the dissipation of some of the water, which is apt to pass off so quickly from the heated loaves.

Several other articles, in addition to those enumerated, are stated to be employed in the adulteration of bread, and there is no doubt but that they have been thus employed, such as *bone ashes*, *bone dust*, *white* *clay*, the *carbonates of soda* and *magnesia*, *chalk* or *carbonate of lime*, and *plaster of Paris*, *gypsum*, or *sulphate of lime.*

Lastly, *sulphate of copper* has been used, principally in Belgium, for the same purposes as alum, viz. to whiten flour, and to cause bread to hold more water.

The results of the examination of numerous samples of flour and bread for alum, may now be stated.

Of twenty-eight samples of bread tested for alum, that substance was found in every one of the samples.

Some time subsequently, a second series of samples of bread, twenty-five in number, were also tested for alum, and this salt was found in the whole of the samples.

Three of the bakers whose bread was examined, and found to contain alum, declared that they did not add that substance to their bread; and they placed in our hands samples of the flour of which the breads were made, when the alum was found in the flours.

From this it may be inferred that the alum had been introduced into the flours by the millers. This discovery led to the examination of other flours, in several of which alum was also detected.

In the course of our investigations respecting the adulteration of bread, we did not fail to pay some attention to the subject of *weight*, a subject second in importance only to that of the adulteration of bread. We procured a number of loaves of bread from different bakers, as delivered to houses, and weighed them. The results were, that thirty-one and a half loaves, obtained from thirteen different bakers, were deficient eighty-six ounces. Scarcely a single loaf reached its proper weight.

In order to check dishonesty in the weight of bread, the following simple plan is in operation in Edinburgh, and it is described by the gentleman who suggested it as having worked exceedingly well.

It is made imperative on the baker to stamp the weight upon all the loaves he sells. The provision to this effect is contained in the Police Act of Edinburgh.

Some idea of the extent to which flour is adulterated, and the feeling which exists in the mind of the people in regard to it, may be gathered from the fact that extensive People's Flour Mills, supported mainly by the working classes, have been established in a great many of our large manufacturing towns, as, amongst others, Leeds, Hull, Barnsley, Bradford, Thirsk, Bristol, Keighley, Halifax, Rochdale, &c.

On the Detection of the Adulterations of Flour and Bread.

The various substances and articles employed in the adulteration of flour and bread, may be classified into the *organic* and *inorganic:* under the first head are included bean, rice, rye, barley, and Indian corn flours, potato flour, and potatoes; under the second, alum, plaster of Paris or sulphate of lime, gypsum, terra alba or mineral white, silicate of magnesia, white clay, carbonates of lime, magnesia, and soda, bone ashes or phosphate of lime, bone dust.

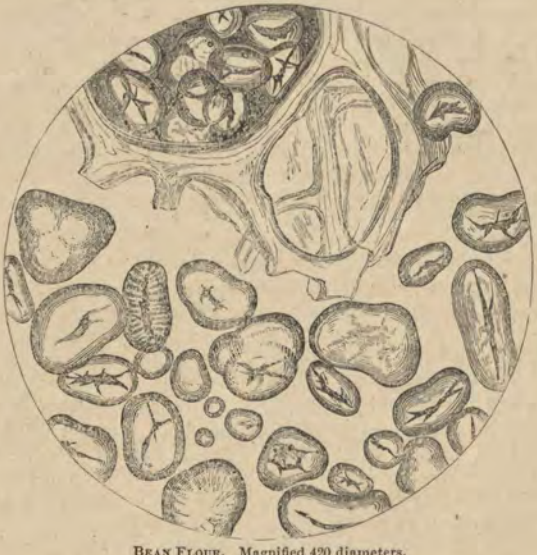
On the Detection of the Organic Adulterations of Flour and Bread.

The only means by which the adulterations of flour and bread with the different kinds of flour enumerated can be discovered, is by the microscope.

The discovery is very much more easily effected in flour than in bread, because the heat to which bread is subjected in baking alters somewhat the original form of the starch granules, and so renders their identification less easy.

The characters of the starches of the several flours used in the adulteration of flour and bread have already been described, with the exception of potato starch and bean flour.

Fig. 99.

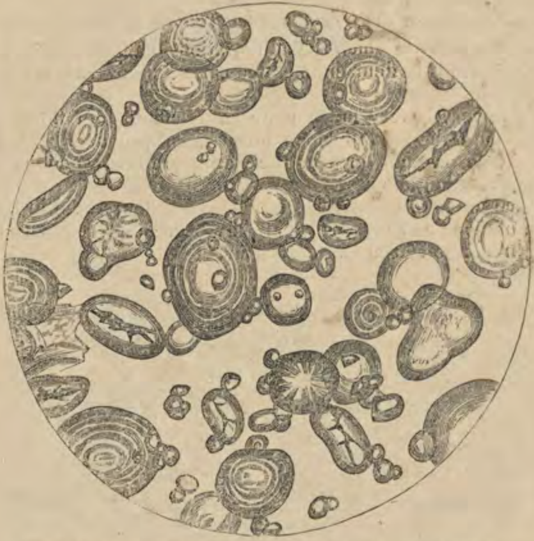


BEAN FLOUR. Magnified 420 diameters.

Bean flour and starch are distinguished from the other flours used in the adulteration of wheat flour and bread by the oval or reniform shape of the granules, the elongated and divided character of the hilum, and the thickness of the walls of the cells enclosing the starch corpuscles. *Fig.* 99.

A description and figure representing the characters of potato flour will be found under the article Arrowroot.

Fig. 100.



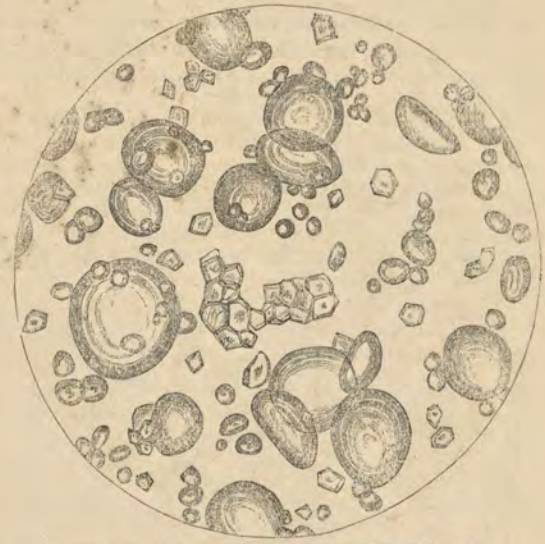
WHEAT FLOUR, adulterated with *Bean flour*. Magnified 420 diameters.

The adulteration of wheat flour with barley flour is one by no means easy of discovery when we confine our observations entirely to the form of the starch corpuscles of the two kinds of grain, the differences in the characters of the starch not being very considerable. The corpuscles of barley starch are smaller than those of wheat, and this is nearly the only tangible difference. However, the discrimination may be effected in a very satisfactory manner, by means of the portions of husk present in the flour. The structural peculiarities of the testa and of the cells forming the surface of the grain of wheat and barley, have already been pointed out, and to the description of these reference may now be made.

In the examination of bread, in consequence of the alteration experienced in the form of the starch corpuscles by the heat of the oven in baking, it is in some cases especially necessary to look carefully to the structure of the portions of husk met with, and of which figures and descriptions have already been given.

Now, although nothing is more common than the use of mashed potatoes in bread, yet, so far as our experience goes, it is by no means easy to detect their presence in bread. To what circumstances this is owing we are not quite sure: the mashed potatoes are not usually

Fig. 101.



WHEAT FLOUR, adulterated with *Rice*. Magnified 420 diameters.

added direct to the flour, but they are generally incorporated with the yeast, which is allowed to remain in contact with them for some hours, this being said to feed and grow upon the potatoes. It is possible that in this way the majority of the cells of the potato become broken down and no longer recognisable. In a few cases, however, we have succeeded in detecting potato in bread by means of the microscope.

The adulteration of flour with Durra, is also discoverable by means of the microscope.

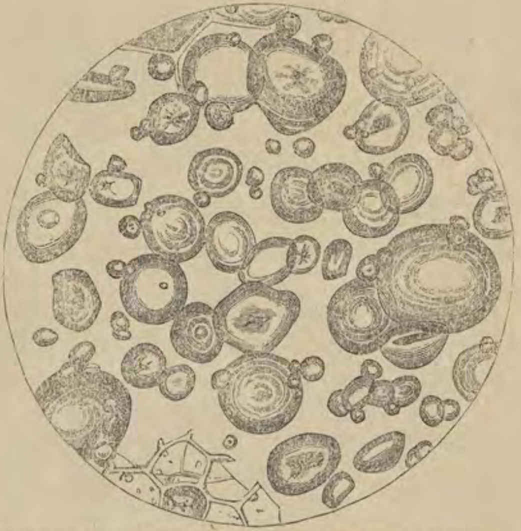
On the Structure of "*Durra*," *Holcus Durra sativus, Forskäl; Sorghum vulgare.*

The testa of the grain or seed may be described as consisting of three membranes.

The *outer* is composed of three or four layers of thick-walled cells, rather small, about three times longer than broad, and having the margins finely beaded, somewhat as in capsicum.

The *middle* coat consists of several layers of cells, with thin walls, and filled with small but angular starch corpuscles.

Fig. 102.



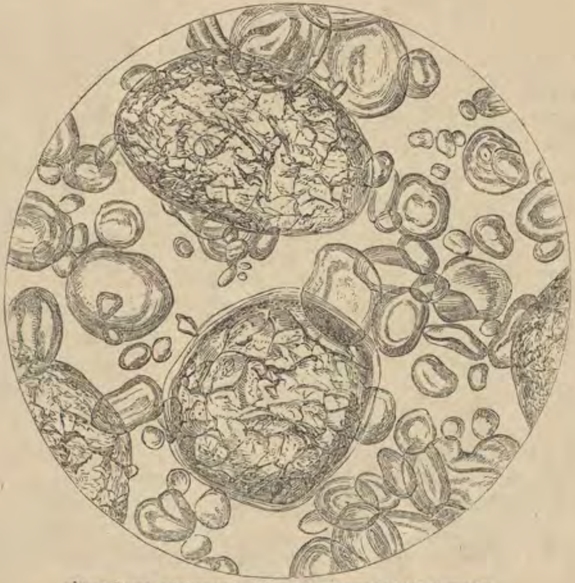
Wheat Flour, adulterated with *Indian Corn flour*. Magnified 420 diameters.

The *third* tunic resembles that of most of the other seeds of the gramineæ, and consists of a single layer of angular gluten? cells, but which are unusually small.

The substance of the seed resembles very closely that of Indian corn, differing chiefly in the larger size and greater angularity of the starch corpuscles, as well as the stellate character of the hilum. See *fig*. 104.

The last organic adulteration, the method for the discovery of which we have to describe, is that with *bone dust*. Bone dust consists of the dust or flour of bones; now bones possess a well-defined structure which is to some extent traceable in the flour: again, bone flour consists in large part of phosphate of lime; this, on the application of nitrate of silver, turns yellow. If, then, on examining any sample of flour with the microscope, we discover minute bony particles, or if, on adding a small quantity of a solution of nitrate of silver to the flour, while under the microscope, particles of a deep and rich golden yellow appear, it is certain that the flour is adulterated with bone dust. The quantity of bone dust used must be calculated from the quantity of phosphate of lime contained in the ash of a given quantity of the flour.

Fig. 103.



Wheat Bread, adulterated with *potato*. Magnified 420 diameters.

The method for determining the presence and quantity of phosphate of lime, is as follows: —

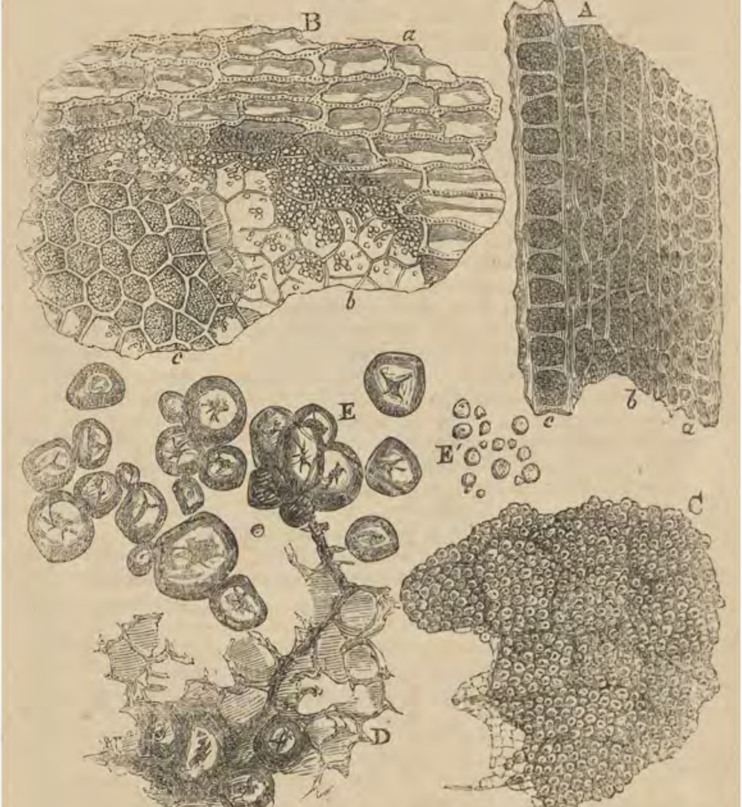
The ash, after being weighed, is to be treated with water; this will dissolve out the soluble salts: next with hot acetic acid which will take up the phosphate of lime. The phosphoric acid and the lime are then to be separately precipitated, the one by means of acetate of lead, and the other by oxalate of ammonia; the precipitates must be collected, weighed, and calculated for phosphate of lime.

In most cases it will be sufficient, after the removal of the soluble phosphates from the ash by means of water, to precipitate the phosphoric acid only, and to calculate this for phosphate of lime. (See p. 259.)

On the Detection of the Inorganic Adulterations of Flour and Bread.

On the Detection of Excess of Water in Bread.—There are two methods by which the presence of water in excess may be determined, one direct, the other indirect; thus if we discover the presence of rice in bread, we ascertain indirectly the fact of the existence of a surplus of water: in the direct method. a weighed portion of the bread is evaporated in a water-bath, until it ceases to lose weight;

Fig. 104.



A, transverse section of testa. *200. *a*, outer; *b*, middle; *c*, inner coat. B, longitudinal section of testa, *200. *a*, outer; *b*, middle; *c*, inner tunic. C. *100, *substance* of seed, showing the large angular cells filled with starch, of which it is composed. D. *500, parts of large cells, showing the pseudo-cell structure, in which the starch corpuscles are separately lodged. E E, *500, starch from testa and from substance of grain.

the loss gives the quantity of water, which, in ordinary cases, amounts to 66 parts in 150 parts of bread.

The processes for the detection of *chalk* or *carbonate of lime*, *gypsum* or *sulphate of lime*, and *silicate of magnesia* or *soapstone*, have already been described; that for the first-named substance will be found at page 101., that for the second at page 99., and that for the third at page 101.

We have then only to consider the methods by which mineral white, white clay, carbonate of magnesia, carbonate of soda, alum or sulphate of potash and alumina, and sulphate of copper, may be detected and estimated.

On the Detection of Mineral White or Terra Alba, &c.—Mineral white is a hydrated sulphate of lime; the process, therefore, for its detection is the same as for sulphate of lime.

On the Detection of China or Cornish Clay.—The process for the discrimination of these earths, the composition of which is nearly identical, and which consist essentially of silicate of alumina, resolves itself into an analysis for silica and alumina, the processes for the detection of which have already been detailed; that for alum is given at p. 294. As the flour in which it occurs may contain alum, the sulphuric acid must be determined, and a corresponding amount of alumina deducted.

On the Detection of Carbonate of Magnesia.—The next salt employed to adulterate flour, the process for the detection of which has to be described, is carbonate of magnesia. For the discovery of its presence, we may proceed as follows:—In order to ascertain whether it or any other carbonate is present, a little hydrochloric acid should be added to a small quantity of the bread or flour spread out on a slip of glass, and while it is under observation with an inch object glass. If ever so slight an effervescence appears, some carbonate is surely present, it may be of lime or magnesia. The processes for determining the presence of lime, and estimating its amount, have already been described; that for magnesia is as follows:—

The ash is to be treated with a little dilute hydrochloric acid, water added, and the solution filtered. Ammonia and oxalic acid or oxalate of ammonia are now added, till no further precipitate takes place; this precipitates any lime which may be present; the liquid is again filtered and treated with chloride of ammonium, and ammonia added in slight excess. Should a precipitate form on the addition of ammonia, more chloride of ammonium must be added, until the precipitate is redissolved; lastly, phosphate of soda in excess is added, the mixture stirred with a glass rod, and allowed to stand at rest for some hours.

The magnesia is precipitated in the form of phosphate of magnesia, the precipitate is collected upon a filter; when the fluid has drained off, it is to be treated repeatedly with a mixture of water and ammonia, in the proportion of four-fifths of the former to one of a solution of the latter. This operation is repeated until the fluid passing through the filter ceases to leave a residue when evaporated on a platinum knife. The precipitate is now dried, transferred to a platinum crucible; this is exposed for some time to a gentle heat, which is afterwards increased to intense redness: lastly, the precipitate is weighed, and calculated, for carbonate of magnesia, by two sums. By the first the quantity of magnesia in the pyrophosphate is ascertained, and by the second this magnesia is converted into the carbonate of that base.

The light, porous, and bulky character of the ash of any flour containing magnesia, is itself sufficient to excite suspicion of the presence of that substance.

The next salt employed in the adulteration of flour and bread, the process for the detection of which it is necessary to describe, is alum.

On the Detection of Alum.—This salt consists of a sulphate of alumina and potash. In general, in analysing flour or bread for this substance, it is not necessary to do more than estimate quantitatively the alumina; it is safest, however, when we desire to exclude every possibility of a mistake, to estimate the sulphuric acid as well.

The following is one of the best processes which can be adopted:—

Incinerate 1000 grs. of the flour or bread; boil in a flask with 4 drachms of nitric acid, 4 of hydrochloric acid, and 4 of water; evaporate to dryness. When cold add one ounce of distilled water, and boil for a few minutes; while boiling dilute with one ounce liq. potassæ. and boil again for a few minutes; then filter, nearly neutralise with hydrochloric acid, and precipitate with ammonia.

The precipitated alumina should be washed, dried, ignited in a platinum dish, weighed, and calculated for alum.

The purity of the reagents employed in this analysis should be previously ascertained, especially that of the solution of potash; indeed, it is safest to prepare these oneself: the nitric and the hydrochloric acid may be obtained pure by simple distillation; and pure potash, from which the solution can afterwards be made, may be procured by the action of alcohol. Mistakes have frequently occurred in consequence of a neglect of these precautions. When the potash contains a minute quantity only of alumina, this may be deducted from the general result.

It should be remembered that salt sometimes contains *minute* quantities of alumina, as well as, it is alleged, certain descriptions of wheat.

The quantities of alumina in two samples of salt analysed, amounted in the one sample to 0·05, and in the other to 0·06 per cent.; we must therefore not infer the presence of alum in bread, when quantities of alumina are discovered as small as those just referred to.

Some chemists have described the following method for the detection of alum:—

Soak the flour or bread in water, filter the solution and treat with ammonia, the precipitate which ensues is described as alumina. This process is utterly fallacious, as a precipitate always occurs under such circumstances, even in the absence of alum, the precipitate in general consisting of nitrogenous matter and earthy phosphates. We refer to this process in order that it may be avoided.

On the Detection of Sulphate of Copper.—For the detection of copper in bread, the processes described under the head of Pickles may be followed.

Ferrocyanuret of potassium is a very delicate test for copper in bread: if the bread be moistened with a solution of that salt, it will assume a pink tinge, more or less deep according to the quantity present. It is stated that the presence of one part of copper in 9000 of bread may be discovered in this way. For the discovery of copper in the ash, 3000 or 4000 grains of the bread should be incinerated.

Duty on all flour and meal 4½*d.* per cwt.

Entered for Home Consumption.

	1854.	1855.	Nine Months of 1856.
	Cwts.	Cwts.	Cwts.
Wheat meal	3,679,699	1,922,101	3,234,717
Barley meal	75	521	138
Oat meal	456	752	5,321
Rye meal	2,842	947	5,626
Pea meal	5	1	35
Bean meal	1	169	—
Indian corn meal	55,963	12,154	7,362
Buck wheat meal	66	3,574	67
Total of meal	3,739,107	1,940,219	3,253,266
	Qrs.	Qrs.	Qrs.
Grand Total of Corn and Flour in its equivalent of Grain	7,858,010	9,260,164	6,431,718

BUTTER, AND ITS ADULTERATIONS.

From Bread we pass on to Butter and its Adulterations.

As the method of making butter may not be known to many of the readers of this report, we will proceed, before entering upon the consideration of its adulterations, to give a very brief outline of the manner in which butter is usually prepared.

Butter is made for the most part from cream; the cream is collected from time to time, and placed in a covered jar, until sufficient has been obtained, when, having become sour by keeping, it is submitted to the process of churning.

Butter is also prepared in small quantities from sweet cream, and this kind is esteemed a great delicacy. Very excellent butter is likewise sometimes made from full or entire milk; the disadvantages of this method are, the large quantity of fluid to be acted on by the churn, which renders it necessary that steam or some other powerful mechanical means should be had recourse to, and the length of time which elapses before the butter forms.

As soon as the butter has formed, it is removed from the churn, and well washed in water, it being kneaded at the same time until as much as possible of the adherent and incorporated whey is removed; this is known by the water ceasing to become turbid and milky. If intended for salt butter, the salt should be added as soon as possible after churning and washing, as, left for any length of time, the butter is apt to become rancid. Great attention should be paid to the quality of the salt used; the best descriptions are rock salt, and that prepared from salt springs. Sea salt, generally, is not so good, on account of the presence of sulphate of magnesia, which renders it somewhat bitter, as well as of chloride of calcium, which has a strong affinity for water, even attracting it from the atmosphere.

It would be out of place in this report to enter into the practical minutiæ of butter-making, such as the temperature at which the cream or milk should be churned, the best kinds of churn, the methods of churning, &c., all points of the greatest importance.

According to Chevreul and Messrs. Bromeïs and Heintz, butter contains margaric, butyroleic, butyric, capronic, caprylic, and capric acids, together with glycerine. The margarine or margarate of glycerine of butter is solid at common temperatures; but the combinations of its other fatty acids with glycerine, constituting butyroleine, butyrine, capronine, capryline, and caprinine, are fluid.

According to Bromeïs, 100 parts of butter contain about 68 parts of margarine, and 30 of butyroleine; the remainder consists of the glycerine compounds of the other acids.

The oily or buttery part exists in milk in the form of innumerable very distinct globules, of various sizes. The effect produced by churning is to break down the greater number of these globules, which then run together, and thus form butter. The operation of the churn is therefore chiefly, if not entirely, mechanical.

Examined with the microscope, butter is seen to contain a great number of milk globules, but little altered in form and size; unlike lard, no crystals of stearine are perceptible.

Referring to works treating on Food, we do not meet with any facts relating to the adulteration of butter.

ON THE ADULTERATIONS OF BUTTER.

One of the most frequent practices had recourse to in the case of butter, is to incorporate with it large quantities of *water;* the incorporation is effected in the following manner: the butter is brought to the melting point, water and *salt* are then stirred in until the mixture becomes cold.

In reference to the adulteration of butter with water and salt, Professor Calvert, in his evidence before the Parliamentary Committee on Adulteration, made these remarks:—"The quantity of water and salt that such an article as butter ought to contain is 2½ per cent. of salt, and 10 per cent. of water. In the butter supplied to these unions the quantity of salt varied from 2 up to 14 per cent., and the water from 10 to 15 per cent."

Another adulteration to which butter is occasionally subject, especially the inferior kind known as Bosh, consists in the addition of *starch,* usually *potato flour.* This adulteration is practised only at particular times, and is dependent upon the wholesale price of butter.

Again, butter has been known to be adulterated sometimes with curds. This adulteration is particularly mentioned by Sir John Gordon, mayor of Cork, in his evidence before the Parliamentary Committee above referred to.

Lastly, *animal fats* are occasionally, though not frequently employed, as the fat of *veal,* and *lard;* these adulterations, again, are only resorted to when butter is very dear and lard the reverse.

Results of the Examination of Samples.

The examination of *Forty-eight* different samples of butter, both salt and fresh, furnished the following results:—

That all the *salt butters* examined contained variable and usually very large quantities of *water,* the amount ranging, with one exception, from 8·48 to 28·60.

That the *fresh butters* likewise contained variable and often considerable quantities of *water,* but in most cases very much less than in the salt butters, the quantities ranging from 4·18 to 15·43.

That the quantity of *salt* contained in the *salt butters* varied from 1·53 to 8·24, showing that no fixed rule is acted upon in salting butter.

That in the *fresh butters* the *salt* varied from 0·30 to 2·91.

That the per-centages of butter contained in the samples ranged from 67·72 to 96·93; that is, some of the samples contained 20, 30, and in one case even nearly 35 per cent. of water and salt.

Now the presence of water in butter, in excess and when purposely introduced, assuredly constitutes an adulteration as much as does the addition of starch or animal fats.

To many of the samples of salt butter examined, a quantity of salt over and above the amount necessary to insure the preservation of the butter had no doubt been purposely added to increase the weight and bulk; in fact, for the sake of adulteration.

It is equally certain that much of the water met with in many of the samples had been added for the same purpose. The quantity of water present in some inferior descriptions of butter, as especially Bosh and the worst kinds of "Hollands," is really surprising, amounting in some cases to more than a third of the article.

On the publication of our Report on the Adulteration of Butter in "The Lancet," Mr. Robert Miller, a butter factor of Wellington Chambers, London Bridge, wrote to that journal to the following effect:—

"*To the Editor of* THE LANCET.

"SIR,—Being attracted to the article in your publication of June 4th on the 'Adulteration of Butter,' by the conspicuous mention of my name, I take the liberty of stating that, although I believe in the fidelity of your analyses, there are two things you are wrong in. First, the amount of adulteration in the worst sample is stated to be twenty-six per cent. I account for this thus: The adulterating process is to bring the butter to the melting point, then to stir it in water and salt until the mixture is cold. Fifty per cent. of water may be incorporated with butter in this way; but when you make your purchase, say half a pound, a considerable part of the water of adulteration will escape, and if you put it in paper considerably more will be lost. The next way you might be deceived is, if you ask for Repacks (Irish) or Black Jacks, or Bosh (Holland), the shopkeeper may suspect your scientific object, and give you better butter instead; but if the public adopt your suggestion of melting butter in a clear bottle, they will prove what I have above said, that twenty-six per cent. of adulteration in these butters is understating the amount.

"In the name of the trade, I may thank you for your article; because a neighbouring shop selling 'cheap butter' compels other shops to do so also; but the trade are now aware of the iniquitous article, and are horrified by being thus compelled to cheat their poor customers with '*cheap butter*,' while they are also perfectly aware of the great loss of weight to themselves by cutting up this watery butter in small quantities. The trade would all be glad to give up the sale of adulterated butter if a public movement were made, so as to compel all the shopkeepers to do so at the same time.

"I am, Sir, yours truly,

"*Robt. Miller.*

"Wellington Chambers, London Bridge, June, 1853.

"N.B.—40,000 to 50,000 casks of adulterated butter are annually sold in London, and the trade knows it as well as they know a bad shilling."

There is a practice rather extensively adopted of making a so-called fresh from salt butter; although this is not an adulteration, it is yet a deception, and as the process by which the transformation is effected is rather ingenious and somewhat amusing, the reader may be interested by a description of it.

"*Epping Butter.*

"*To the Editor of* THE LANCET.

"SIR,—Having taken apartments in the house of a butterman, I was suddenly awoke at three o'clock one morning with a noise in the lower part of the house, and alarmed on perceiving a light below the door of my bedroom; conceiving the house to be on fire, I hurried down stairs. I found the family busily occupied; and on my expressing alarm at the house being on fire, they jocosely informed me, they were merely making EPPING BUTTER!

"They unhesitatingly informed me of the whole process. For this purpose they made use of Irish salted butter of a very inferior quality. This was repeatedly washed with water, in order to free it from the salt. This being accomplished, the next process was to wash it frequently with milk, and the manufacture was completed by the addition of a small quantity of sugar.

"The amateurs of fresh 'Epping butter' were supplied with this dainty, which yielded my ingenious landlord a profit at least one hundred per cent., besides establishing his shop as being supplied with Epping butter from one of the first-rate dairies.

"I am, Sir, your obedient servant,
"*A Student.*

"York Road, Lambeth, June, 1853."

Perceiving, then, to what an extent salt butter is adulterated, with both water and excess of salt, we very much doubt whether any saving is effected by the use of this description of butter; although nominally cheaper, it is questionable whether it be not really dearer in the end.

On the Detection of the Adulterations of Butter.

The chief adulterations of butter are with water, starch, excess of salt, and animal fats.

On the Detection of Water.—After being churned, butter is kneaded in water in order to get rid of the whey with which it is incorporated; the adoption of this process would account for the presence of a small quantity of water in butter.

There are two methods by which the quantity of water in butter may be determined; one simple and popular, the other more scientific and exact.

First Method.—The butter is to be melted, and a bottle filled with it. This is to be placed, for half an hour or so, near the fire; the water and salt will become separated from the butter, and sink on account of their greater weight or specific gravity. Owing to the water being mixed with a little whey, it usually presents a white and milky appearance, very distinct from that of the butter itself, which floats upon it, and which is more or less yellow; the quantity of water is then roughly estimated by noticing the height it reaches up the bottle. In many cases it will be found that the water constitutes a fourth and even a third of the article.

Second Method.—One hundred grains of the butter, which must not have been previously exposed to the air, or part of the water will already have become dissipated and lost, must be evaporated in a small glass or porcelain dish or capsule, over a water-bath, until it ceases to lose weight; the butter and the capsule must then be weighed, and the weight of the capsule deducted; the deficiency on the original 100 grains represents the per-centage of water contained in the butter.

It is possible, that in some cases the question might arise, as to whether the fluid separated on melting butter, consisted of water or whey, or of both mixed; this point may be determined by estimating the amount of sugar of milk present in the liquid. This is effected by the process described in the article Milk. One thousand grains of whey usually contain about sixty grains of sugar of milk.

On the Detection of Starch.—Starch in butter may be readily detected and its amount estimated. For its detection, nothing more is necessary than to examine a minute portion of the butter spread out in the thinnest possible layer, and covered with a plate of thin glass, with a half or quarter-inch object glass, tincture of iodine being in some cases employed at the same time. The starch will be recognised by the form of the granules and the action of iodine.

To estimate its quantity, the following proceeding may be adopted:—The butter may be melted, when the starch will separate with the water; the precipitate may be collected on a filter, dried, and weighed; or the fat may be removed by means of ether, when the residue will consist chiefly of the starch.

On the Detection of Lard.—We are not acquainted with any very direct method by which the presence of lard in butter may be discovered. So far as we have observed, one of the best tests is furnished by the microscope: lard consists, in the solid state, in great part of crystals of margaric and stearic acids, while in butter no such formations are met with, but only numerous milk globules. When, therefore, crystals similar to those represented in *fig.* 105. occur, there is good reason to suspect the admixture of lard.

Again, the melting points of lard and butter somewhat differ.

On the Detection of Salt.—A weighed portion of the butter must be incinerated, and the salt determined from the ash. In general the whole of the ash of salt butter may be counted as salt.

Duty, 5*s*. per cwt.; 2*s*. 6*d*. from British possessions.

Imports taken for home consumption: 1854, 478,811 cwts.; 1855, 448,268 cwts.; nine months of 1856, 363,877 cwts.

LARD, AND ITS ADULTERATIONS.

Lard is the oily portion of the fat of the pig. The process by which this is separated from the vesicular, fibrous, and vascular tissues in which it is either enclosed, or by which it is surrounded, is termed *lard rending*.

The pieces of fat to be converted into lard are sometimes salted a little, the better to ensure their preservation, and are stored in barrels. The fat which immediately surrounds the kidneys yields the best and purest lard; this is owing to its being in a freer state, that is, it is less highly organised. The process is as follows:—The pieces of fat are scored or sliced into lesser portions of an inch or so in diameter; they are placed, either with or without the addition of a little water, in cauldrons, which are usually of iron. The mode of applying heat to the flare varies in different cases. When lard is made on a small scale the flame is often applied directly to the containing vessel; sometimes the flare is melted in a water-bath, but usually the heating medium is steam, which is contained in the interval between the inner and outer vessel or pan; occasionally a jet of steam is thrown directly upon the flare contained in the copper. The soluble part of the fat melts out and floats on the surface, the animal matter and tissues each forming a scum, which is skimmed from time to time, or sinking as a deposit. As the oil has no affinity for either water or salt, it does not take up any of the water which may be present with it in the copper, while the salt used to preserve the fat falls as a sediment. The oil whilst still warm and fluid is turned out of the copper through a tap, and is received either into bladders or casks termed kegs, and hence the division of lard into *bladder lard* and *keg lard*. It is usually the best description of lard only which is stored in bladders, keg lard being for the most part of inferior quality. Good and pure lard should be entirely free from either taste or smell; it should be firm and white, and when melted be almost as clear and transparent as water; subjected to a temperature of about 212° Fahr., it should liquefy without ebullition, thus showing the absence of water, and should not throw down a particle of deposit. Inferior or adulterated lards possess characters and properties almost the reverse of these. The melting point of lard varies from 78·5° to 87·5° Fahr. According to Braconnet its composition is as follows:—

Proximate Analysis of fresh Lard.

Stearine Margarine	38
Elaine	62
	100

Our supplies of lard are derived principally from Ireland, part also comes from America and Hamburgh, while London and our chief provincial cities possess lard manufactories.

The Adulterations of Lard.

We have long been aware that lard, like nearly every other article of consumption, is liable to adulteration; indeed, the fact that it is so is very generally known to dealers as also the nature of the principal adulterations practised.

The chief adulterations of lard resemble those of butter, and consist in the incorporation with it of water and starch. Sometimes the water only or the starch only is had recourse to; in others both these adulterations are practised on the same lard.

We have ourselves met with many samples of lard adulterated with potato flour; but one of the earliest to draw attention to the subject was Mr. George Whipple in a communication which he brought before the Pharmaceutical Society, and which was noticed in its Journal for January 1853; in this he states that he had detected large quantities of some farinaceous substance in lard.

"This adulteration," writes Mr. Whipple, "was discovered in the different varieties of lard — from the finest bladder to the common firkin lard. In an examination of the contents of two firkins, weighing 105½ lbs., a quantity of farinaceous substance, amounting to 22¼ lbs., was separated. The contents of another firkin, weighing 43¾ lbs., yielded 12¾ lbs. of a similar substance."

In the next number of the same journal, Mr. Calvert, of Manchester, published some further observations on the adulteration of "American lard." He writes — "During the numerous analyses I made some three years since, of various articles of food employed in public establishments, I analysed several samples of American lard, and therefore may add to the fact already mentioned by Mr. George Whipple in your last number, that I found them to contain, in addition to starch, from ten to twelve per cent. of water, and from two to three per cent. of alum, and about one per cent. of quicklime.

"A few months ago I was able to ascertain that the operation is conducted in the following manner: —

"The fatty matters, such as they arrive from America, are melted with a little water in false-bottomed copper pans, through which circulates a current of steam. The dirt and other heterogeneous matters fall to the bottom of the pans, and the clear grease is allowed to run into a wooden vessel, when it is stirred in contact with cold water; it is then put under revolving wheels with a thick paste made of potato starch, mixed with a little potash alum and quicklime, which appears to facilitate the taking up of the water and starch by the fatty matter.

"The cause of the American lard appearing so white is, no doubt, the division of the fatty matter through the interposition of the starch, water, and alumina.

"The quantity of alum should be such that a small excess should remain to prevent the starch from becoming mildewed; and I believe that the manufacturer also adds it for the purpose of communicating to the lard the property of facilitating the raising and increasing the whiteness of the confectioners' paste, in which it is largely employed."

It should be understood, that American lard, as brought to this country, is not in general adulterated. The adulteration usually takes place subsequent to its arrival, and is the work of some of our own manufacturers. The reason why American lard is so frequently selected for adulteration is, that it is of inferior quality and value, and so soft as to be almost fluid, some process of consolidation being indispensable before it can be employed as lard.

From information received from a respectable lard render, it appears that the addition of a small quantity of *mutton suet* to lard is very common. It is used more particularly in warm weather, and with soft lards, especially American lard, which differs from ordinary lard, in that it consists of the entire fat of the pig melted down, and not, as is the case with the best English lard, of the fat only which surrounds the kidneys. Mutton suet, being a hard and firm fat, imparts to soft lards, even when added in very small quantities, the consistence and solidity requisite.

It appears, therefore, that water, starch, alum, and caustic lime have all been ascertained to be employed in the adulteration of lard. To these substances we may add the following: — carbonate of soda, carbonate of potash, and salt. The whole of the above adulterations may be readily discovered.

Possibly in some cases other animal fats are used, as that of *veal.*

Results of the Examination of Samples.

The results of the examination of upwards of 100 samples of lard were as follows: —

1st. That lard is not unfrequently *extensively adulterated*, the ingredients employed being *water* and *potato flour*, as well as certain saline substances, as *salt, potash alum, carbonates of potash* and of *soda*, and *caustic lime*, these being intended either to cause the lard to hold water, or to improve its consistence and colour.

2nd. That the description of lard most liable to adulteration is *keg lard*, and of this, particularly that which is manufactured in England; Irish keg lard being but rarely adulterated.

3rd. That of upwards of *one hundred* samples of lard submitted to examination, and procured chiefly from retail dealers, *seven* were found to be adulterated with *potato starch*.

The adulteration of lard prevails not only in certain localities, but also chiefly at certain times—that is, whenever a sufficient supply of inferior lard, suitable for mixing, can be procured; for it is said not to answer to adulterate a lard of good quality, which commands a high price, and which is spoiled by being tampered with.

It will be readily perceived that the qualities of a lard thus adulterated must be seriously impaired for almost every purpose for which it is employed: thus, of course, it would not be nearly so economical for culinary purposes. In the presence of large quantities of potato flour the cook will find a sufficient explanation of the extraordinary tenacity with which fish sometimes adheres to the frying pan. Again, the use of such lard in machinery might, in some cases, produce serious consequences by impeding its action. Lastly, the activity of all the ointments of the Pharmacopœia, made with such a lard, would be much injured, especially the simple and compound iodine ointments, which, if starch were present, would, to the astonishment of the dispenser, turn blue, or almost black, in the act of incorporation.

On the Detection of the Adulterations of Lard.

The first thing to be done in order to ascertain whether a lard be genuine or adulterated, is to melt it at about a temperature of 212° Fahr. If it dissolve without ebullition or without the occurrence of a deposit, we may safely conclude that the sample is genuine; but if ebullition take place, or a sediment is thrown down, the lard is unquestionably adulterated.

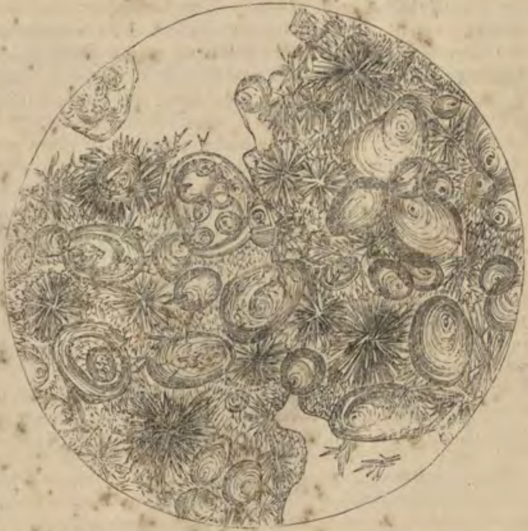
Detection of Water.—The adulteration with water, and the quantity present, may be thus determined:—A known weight of lard is to be exposed to heat until bubbles of vapour cease to escape; the loss indicates the per-centage of water.

Detection of Starch.—The presence of starch may be discovered by thoroughly incorporating a solution of iodine with a few grains of the lard, placed upon a slip of glass; the lard will change colour, and become deep blue, or almost black. If now a little of this be viewed under the microscope, the starch corpuscles will themselves be seen coloured by the iodine.

To determine the kind of starch contained in any sample, we must use the microscope. A minute piece of the lard should be placed on a glass slide, previously thoroughly warmed; the moment the lard is melted it must be viewed by the object glass, when the starch corpuscles will be distinguished standing out as clearly as though they were in water.

Another way in which the starch corpuscles may be well seen by the microscope, is to spread out by gentle pressure, between two pieces of glass, a very thin stratum of the lard.

Fig. 105.



LARD, adulterated with *Potato starch*. Magnified 240 diameters.

Although it is easy enough to detect starch in lard, it is by no means so to estimate the amount present.

Ether does not readily dissolve lard, particularly in cold weather, so that by this reagent it is very difficult to separate all the lard from the other ingredients with which it may be admixed. If, however, ether be used for the purpose, the lard should be melted, and, while still warm, the ether should be poured upon it; we may then weigh, when properly dried, either the oil obtained, or the sediment left. Still, with every precaution, this method of separation is very troublesome, and often fails.

Another method is as follows:— Put one hundred grains of the lard in a test tube; apply a gentle heat until all escape of vapour ceases. Fill nearly up with water; heat as before; allow the oil which has risen to the surface to become cold; collect; heat again with a little more water, when a second portion of oil will be obtained; add the two portions together, dry, and weigh.

Although this method is simple, it is very troublesome, and gives only approximate results, since it is almost impossible to separate all the oil by heat alone.

The separation of the oil is said to be readily effected by means of essence of turpentine.*

Determination of Saline Matters.—For the determination of the saline matters present, it is in most cases sufficient to melt the lard, collect the precipitates, free them from oil with ether, weigh, and afterwards taste them. Salt, alum, and lime may all be distinguished, provided quantities of lard sufficiently large be operated upon, by the taste alone.

The processes for the detection and estimation of alum are given at p. 294., of salt under Annatto, and of lime at p. 101.

It is not often that more than one or two of these salts occur together in the same lard: supposing them, however, to do so, we may proceed generally as follows:—Incinerate 2000 grains of the lard, dissolve out the salt with distilled water, precipitate the chlorine by means of nitrate of silver, and estimate the soda from this; boil the insoluble portion of the ash with dilute hydrochloric acid, divide into two portions, precipitate the lime from the one by means of oxalate of ammonia, and the alumina from the other with strong ammonia, according to the process given under the head of Bread.

Lard is free of duty; consequently we can give no account of quantities taken for home consumption: but the imports were in 1854, 274,595 cwts.; in 1855, 118,109 cwts.; in nine months of 1856, 116,120 cwts.

OATMEAL, AND ITS ADULTERATIONS.

Oatmeal, as its name implies, consists of the farina or meal of the oat.

The composition, structure, and properties of this cereal grain will be found described to some extent, and figured, at pp. 249, 250., to which the reader is referred.

Amongst the best analyses which have yet been made of the oat are those by Messrs. Norton and Fromberg.

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* Payen, "Des Substances Alimentaires," p. 86. Troisième Edition.

	Hopeton Oats.		Potato Oats.	
	Northumberland.	Ayrshire.	Ayrshire.	Northumberland.
Starch	65·24	64·80	64·79	65·60
Sugar	4·51	2·58	2·09	0·80
Gum	2·10	2·41	2·12	2·28
Oil	5·44	6·97	6·41	7·38
Proteine compounds :—				
Avenin	15·76	16·26	17·72	16·29
Albumen	0·46	1.29	1·76	2·17
Gluten	2·47	1·46	1·33	1·45
Epidermis	1·18	2·39	2·84	2·28
Alkaline salts and loss	2·84	1·84	0·94	1·75
	100·00 N.	100·00 F.	100·00 F.	100·00 N.

The composition of the *husk* of the oat, according to Professor Norton, is as follows :—

	Hopeton.	Potato Oat.
Oil	1·50	0·92
Sugar and gum	0·47	0·75
Gluten and coagulated albumen	1·88	1·88
Cellulose	89·68	89·46
Saline matter and ash	6·47	6·99
	100·00	100·00

The analyses of M. Payen will be found at p. 257.

It appears from these analyses that oatmeal is a highly nutritive article of diet, richer than even wheat flour in oily and nitrogenous matters.

There are several varieties or qualities of oatmeal: one of these is Robinson's Patent Groats; this consists of the finest parts of the flour of the oat, all husk and the outer and harder parts of the grain being removed: another variety is called "round oatmeal;" it consists of the oats deprived of husk and ground into a very coarse powder. This description varies a good deal, the outer surface of the oats intended for the better sorts being rubbed off by attrition between stones.

In the preparation of fine oatmeal there is a good deal of refuse matter, amounting generally to about one fourth or fifth of the entire bulk of the oats: this is composed of a portion of husk, which contains much silex, and the outer part of the grain containing a little starch and much oil and nitrogenous matter; this is usually mixed up with the commoner descriptions of oatmeal, especially that supplied to workhouses.

Lastly, the quality of oatmeal depends very greatly upon the quality of the oat from which the meal is prepared.

ON THE ADULTERATIONS OF OATMEAL.

It could hardly be supposed that sufficient inducement exists for the sophistication of an article like oatmeal; it appears, however, that this supposition is not correct.

Of *thirty* samples of oatmeal submitted to examination, *sixteen*, or rather more than one half, *were found to be adulterated* with large quantities of BARLEY MEAL. But oatmeal frequently suffers deterioration in other ways besides by admixture with barley flour. One of these consists in adding to it the investing membranes, *or husk*, of *the oat*, *barley*, and *wheat*, technically termed "rubble" and "sharps," and which are rejected in the preparation of the purer sorts of oatmeal, grits and groats, Scotch and pearl barley.

On referring some time since to the market prices of oat and barley meals, we found that while the first was 16*s*. per cwt., the latter was only 8*s*. per cwt., that is, just one half. We thus perceive that the inducement to adulterate oatmeal is very great,—greater, indeed, it appears, than many cornchandlers can resist.

The following information, furnished us by a correspondent, whose name, for obvious reasons, we withhold, shows that this article is subject to systematic adulteration. He writes: —

"Since your able analyses have taken place, it has struck me that I may be able to give you a little information as to an article of food which is adulterated to a most *awful* extent,—viz. *oatmeal*. I will first mention oatmeal *as sent into workhouses*, *prisons*, and *charitable institutions*, which are generally taken at contract prices. I enclose one for the parish of —— for 1848, where I find the oatmeal was taken at 14*s*. per cwt. by ——; and by reference to my stock-book, I find the market price was 17*s*. 6*d*. per cwt.; thus the oatmeal was reduced 3*s*. 6*d*., and then left an excellent profit. Well, at that time I was trying for all the contracts in London, and could not succeed, my *prices* being generally about 4*s*. dearer than any one's else: this was a *mystery* to me. By accident I found out oatmeal was adulterated with barley flour which is bought at about 7*s*. per cwt.; this being mixed with the oatmeal, of course reduced the *price*. I then, being as wise as my competitors, tried, and have served the above workhouse since.

"Now, the fault lies here. If the workhouses were to take the contracts at a per-centage on market value, then they would get *good* oatmeal; but they always *cut down* the price, and thus get an adulterated article.

"You will see the prices are 14*s*., 15*s*. 6*d*., 16*s*., and 17*s*.; thus if a man wants to be *honest* with them, *they will not let him*. I have again and again wished to supply at a per-centage on market value; the answer I get is, '*Well, we are very well satisfied, and have no complaints.*'"

We have ourselves been at some pains to verify the statements made above, and for that purpose have procured samples of oatmeal as supplied to some of our unions and charitable institutions; these, without exception, we have found on examination to be largely adulterated with *barley meal*, as described.

Other adulterations of oatmeal are, according to Professor Calvert, with *rice* and *maize.* He states, in his evidence, already referred to in the article Butter: — "I have found oatmeal, generally speaking, in fact always, mixed with rice and maize. The effect is this, it makes less porridge; in other words, it is a direct loss to the ratepayers, because the cook in the workhouse must use a larger proportion of this adulterated oatmeal to make a certain quantity of porridge, than if it is pure oatmeal."

The following evidence was furnished to the Committee on Adulteration, by Mr. Mackenzie, of Glasgow, the editor of "The Reformer's Gazette," in regard to the adulteration of oatmeal: —

"Some few years ago, when great destitution prevailed in the West of Scotland, especially in the Highlands, a large sum of money, amounting to 50,000*l.* or 60,000*l.*, was devoted to furnishing provisions, including oatmeal, to the Highlanders. At that period information was given me that a very large quantity of that oatmeal was adulterated in the grossest manner: a letter was sent to me, which I thought it my duty to publish, and the contractor who furnished the meal referred to in that letter, threatened me with an action of damages. The case was tried, and the contractor found guilty, and adjudged to imprisonment for three months, and to pay a fine of 300*l.* The oatmeal was mixed with bran and thirds, the common food for horses;" thirds being the refuse and shell of the wheat.

"To my amazement," continues Mr. Mackenzie, "the accused brought forward some of the principal millers in Glasgow, to swear that it was quite a common practice in the trade."

The adulteration of oatmeal is not merely important in a pecuniary, but is of some consequence in a sanitary point of view.

The properties of *oatmeal* are thus described in Pereira's "Materia Medica:" — "Oatmeal is an important and valuable article of food. With the exception of maize or Indian corn, it is richer in oily or fatty matter than any of the other cultivated cereal grains, and its proportion of protein compounds exceeds that of the finest English wheaten flour. So that both with respect to its heat and fat making, and its flesh and blood making principles, it holds a high rank."

In the same work we meet with the following account of *barley meal* as an article of diet: — "Barley is a valuable nutritive. Considered in relation to wheat, it offers several peculiarities. In the first place it contains much less protein matter; in other words, less of the flesh and blood making principle; though Count Rumford considered barley meal in soup three or four times as nutritious as wheat flour. Secondly, its starch offers more resistance to the action of the gastric juice, in consequence of its more difficult solubility in water. Thirdly, its husk is slightly acrid, and therefore this should be removed from barley intended for dietetical purposes, as in Scotch and pearl barley. Fourthly, barley meal is more laxative than wheat meal."

Contrasting the two, it appears that oatmeal possesses considerable dietetic advantages over barley meal.

It may be in the recollection of some of our readers, that at the inquest held by Mr. Wakley on the bodies of some of the poor children who fell victims in the pest-house at Tooting, the fact transpired that the oatmeal which formed so considerable a part of their food was extensively adulterated with barley meal.

On the Detection of the Adulterations of Oatmeal.

The principal adulterations of oatmeal, as already noticed, are those with the refuse matter of oats, barley, and even wheat, termed "rubble" and "sharps," and with barley meal: these adulterations may be detected without, in most cases, any considerable difficulty.

On the Detection of "Rubble."—An admixture of Rubble may be suspected when the sample presents a branny appearance in consequence of the presence of numerous particles of husk or bran, as well as of the outer yellow portion of the grain. In order, however, to ensure certainty, it is necessary to resort to chemistry and the microscope. A portion of the article may be analysed quantitatively for silicic acid: the ash of about 500 grains must be boiled with dilute hydrochloric acid; this will dissolve all but the silica, which must be washed, ignited, and weighed.

According to Messrs. Ogston and Way, the ash of oat contains from 38·48 to 50·03 per cent. of silica, barley from 23·6 to 70·77, rye about 9·22, and wheat 20·5 to 54·6 per cent.

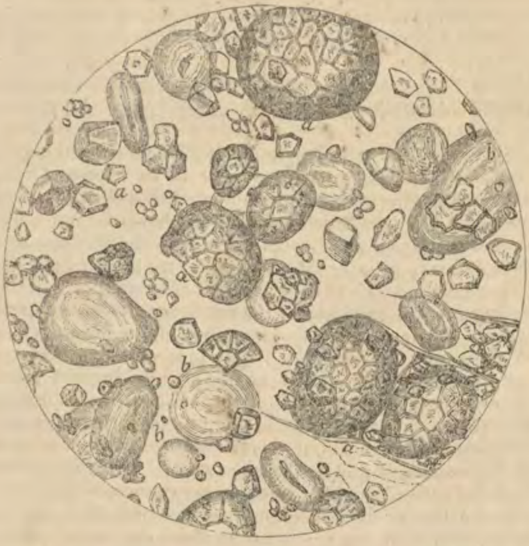
This method of proceeding is rather adapted for the detection of rye and wheat rubble than that of barley. Of course the per-centage of silica in rubble is very much higher than it is for the whole grain.

In those cases in which the *rubble of barley* meal has been used, the starch granules of that cereal may be readily detected by means of the microscope, as also portions of the investing membranes, the structures of which, so different from those of oat, are described and figured at pp. 244, 245.

In like manner, the microscope furnishes the means of discovering the presence of *wheat rubble or sharps* in oatmeal. The starch granules of wheat and barley so nearly resemble each other, that when mixed together, it is not easy to distinguish the one from the other: the investing membranes of the grain of wheat, described and figured at pp. 241—243., are, however, so different from those of barley, that they afford a certain means of discrimination.

On the Detection of Barley Meal.—The microscope affords the only means by which this adulteration can be discovered. The starch granules of oat and barley have already been described and figures of them given; the differences are so great, that a momentary glance with the microscope is all that is necessary to enable the observer to distinguish genuine oatmeal from that adulterated with barley meal. The starch granules of the oat are small, angular, and frequently aggregated into compound bodies of a rounded form, while those of barley are much larger, round, and flat.

Fig. 106.



OATMEAL adulterated with *barley meal*. Magnified 225 diameters.

On the Detection of Rice and Maize.—These adulterations may be promptly discovered by means of the microscope. See *fig.* 85. p. 255., and *fig.* 82. p. 251.

It is very possible, however, to mistake the starch granules of wheat for those of barley; but wheat flour is rarely used in the adulteration of oatmeal: this error may be avoided by a careful examination of the portions of testæ met with, the structure of which in wheat, barley and oat is so very different, as will appear from an examination of the descriptions and figures given under the article Bread.

Customs duty on importation, 4½*d* per cwt. The quantities imported and taken for home consumption, were as follow:— 1854, 456 cwts.; 1855, 752 cwts.; nine months of 1856, 5,321 cwts.

ARROWROOT, AND ITS ADULTERATIONS.

The term "arrowroot" was originally applied to the rhizome or root of *Maranta arundinacea*, in consequence of its supposed efficacy in counteracting the effects of wounds inflicted by poisoned arrows.

Of late years, the signification of the term has been much extended, and it is now employed to designate almost every fecula which bears any resemblance to true or Maranta arrowroot, no matter how dissimilar the plants may be from which it is obtained.

Attending this enlarged use of the word arrowroot are certain disadvantages. Many persons consider that all arrowroots constitute one and the same article, varying only in quality, and according to the place from which they are procured; while but few persons are aware that there are several distinct kinds of arrowroot, the produce of distinct plants, great uncertainty and confusion being thus created.

To increase this confusion, the word "genuine" is often prefixed to the term "arrowroot," and as there are several kinds of arrowroot, so must there be several genuine arrowroots: these vary in value from a few pence to two or three shillings the pound—from, in fact, the value of genuine Maranta arrowroot to that of genuine potato arrowroot. With these particulars the public at large is but ill acquainted.

The difficulty and confusion is still further enhanced by applying to the arrowroot, as is generally done, the name of the place from which it is obtained: thus we have genuine West Indian, Jamaica, Demerara, Bermuda, St. Vincent, East Indian, Brazilian, African, Guinea, Sierra Leone, Portland, British, and a variety of other arrowroots. Some persons suppose that each of these names represents a different kind of arrowroot; others imagine that they all indicate one and the same production; while the fact is, that in some cases, as in that of East India arrowroot, one name may be indiscriminately applied to two distinct kinds of arrowroot, and in others, six or eight names all signify but a single kind or species, as is the case with West India arrowroot. This great variety of names is objectionable, not merely because it tends to confuse the public, but because it offers to the fraudulent great facilities for adulteration and imposition, of which, as we shall see hereafter, they have not failed to avail themselves.

The remedy for this state of things is simple: each really distinct arrowroot, that is, every arrowroot which is the product of a distinct plant, should be designated by the name of the species from which it is derived, as Maranta, Curcuma, Tacca, Manihot, Arum, Potato Arrowroot, &c.

The employment of these terms should not be optional, but *compulsory*, for the better protection of the public against fraud in this article of food. The propriety of this suggestion will become still more evident as we proceed.

We shall now describe each kind of arrowroot separately, observing of them all, that when pure they are non-nitrogenised substances, and therefore adapted to the formation of the fat of the body, and to the maintenance of respiration and temperature.

MARANTA ARROWROOT.

Maranta arrowroot is obtained from the rhizomes of *Maranta arundinacea*, one of the family of the *Marantaceæ.*

A rhizome is an underground jointed stem placed horizontally in the earth, giving off from its upper surface, branches, and from the lower, roots; the starch or fecula is contained in the joints of the rhizome, being deposited in innumerable minute cells.

The following account of its preparation is given by Dr. Pereira in the new and greatly improved edition of his "Materia Medica:" —

"The starch, or fecula, is extracted from the roots (tubers), when these are about ten or twelve months old. The process is entirely a mechanical one, and is performed either by hand or by machine.

"In Jamaica it is procured as follows:—The tubers are dug up, well washed in water, and then beaten in large, deep, wooden mortars to a pulp. This is thrown into a large tub of clean water. The whole is then well stirred, and the fibrous part wrung out by the hands and thrown away. The milky liquor being passed through a hair sieve, or coarse cloth, is suffered to settle, and the clear water is drained off. At the bottom of the vessel is a white mass, which is again mixed with clean water, and drained; lastly, the mass is dried on sheets in the sun, and is pure starch.

"In Bermuda, the roots are first deprived of their paper-like scales, and then rasped by a kind of wheel rasp, and the fecula well washed through sieves and carefully dried.

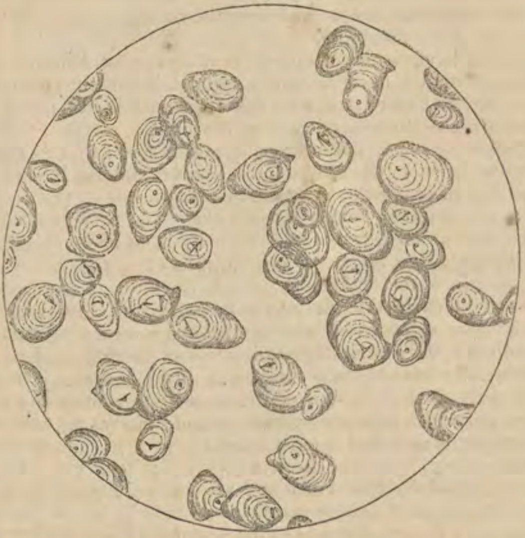
"Upon the Hopewell estate in the island St. Vincent, the carefully skinned tubers are washed, then ground in a mill, and the pulp washed in tinned copper cylindrical washing machines. The fecula is subsequently dried in drying houses. In order to obtain the fecula free from impurity, pure water must be used, and great care and attention paid in every step of the process. The skinning or peeling of the tubers must be performed with great nicety, as the cuticle contains a resinous matter, which imparts colour and a disagreeable flavour to the starch. German silver palettes are used for skimming the deposited fecula, and shovels of the same metal for packing the dried fecula. The drying is effected in pans covered by white gauze to exclude dust and insects."

Pure and unadulterated Maranta arrowroot should be of a dull and opaque white colour, crepitating or crackling when pressed between the fingers, and treated with about twice its weight of concentrated hydrochloric acid it should yield an *opaque* paste.

The above characters and appearances may all, however, be assumed by certain of the other arrowroots; the microscope, therefore, affords the only ready and certain means of distinguishing this arrowroot from all other species, and these again from each other.

Examined with that instrument the granules or particles of Maranta arrowroot are found to be usually more or less oblong and ovate, but sometimes they are mussel-shaped or even almost triangular; they vary considerably in size, but each of the larger granules is marked by a number of delicate concentric lines; at the broad or large extremity of each a distinct spot is visible, ordinarily considered to be a cavity, and denominated the "hilum;" this spot is sometimes circular, but most frequently it is seen as a short, sharp

Fig. 107.



Starch granules of MARANTA arrowroot, called commonly West India arrowroot. Drawn with the Camera Lucida, and magnified 240 diameters.

line, running transversely across the granule; it furnishes a most distinctive feature by which Maranta arrowroot may be at all times very readily identified.

When boiling water is added to Maranta or any other arrowroot, its physical condition undergoes a great and surprising alteration, the nature of which may be clearly traced by means of the microscope. A tablespoonful of arrowroot, on which a pint of boiling water is poured, immediately loses its whiteness and opacity, becomes transparent, and the entire of the water is as it were converted into a thick and jelly-like substance. If a little of this be diffused through cold water, and examined with the microscope, it will be seen that the starch granules are altered amazingly: they have increased to twenty or thirty times their original volume; they are more or less rounded; the concentric lines and the hilum are obliterated; the membrane of each granule is ruptured, and a granular matter has escaped from its interior.

The appellations which have been bestowed upon Maranta arrowroot are very numerous; their use ought to be wholly discontinued, for the reasons already assigned: thus it is sometimes called West India arrowroot, Jamaica, Demerara, Bermuda, Berbice, St. Vincent arrowroot, &c. The impropriety of denominating it West India arrowroot is shown by the circumstance, that the Maranta plant is cultivated in the East as well as in the West Indies.

CANNA, OR TOUS LES MOIS ARROWROOT.

Canna edulis, the plant from the tubers of which the starch known as *Tous les Mois* is obtained, belongs to the natural order *Marantaceæ*, which includes *Maranta arundinacea*, or West India arrowroot.

The starch is obtained much in the same manner as that of the other arrowroots; that is, the tubers are rasped, and the fecula separated from the pulp by washing, straining, decantation of the supernatant liquor, and desiccation of the deposited starch. It is imported from St. Kitts.

The jelly yielded by it is said to be more tenacious, but less clear and translucent, than that of other arrowroots.

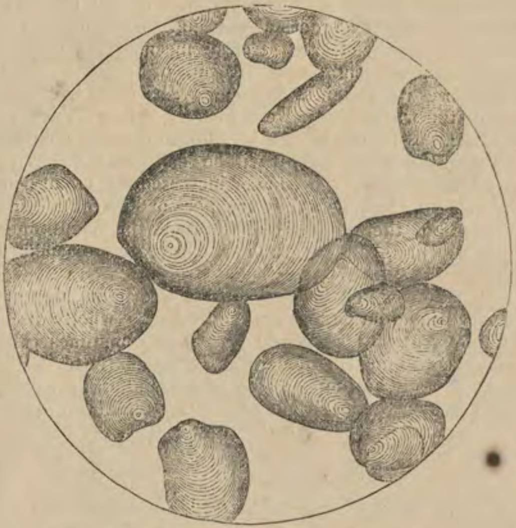
Owing to their large size the starch granules exhibit a glistening or satiny appearance; they differ from other dietetic starches not only in their much greater dimensions, but in certain other particulars.

The granules or corpuscles are nearly all very large, flat, broad, but ovate; sometimes, like those of East India arrowroot, pointed at the narrow end. The hilum is situated in the narrow extremity of the granule, and the rings are exceedingly fine, regular, and crowded.

The only starch with which they are at all likely to be confounded is that of the potato; the granules are, however, larger, of a different shape, being flat, and the striæ are much more regular and numerous.

Viewed by polarised light the crosses are more regular than in potato starch.

Fig. 108.



Canna, or *Tous les Mois* arrowroot. Magnified 225 diameters.

CURCUMA ARROWROOT.

Curcuma arrowroot is obtained from the tubers of *Curcuma angustifolia*, one of the family of the *Zingiberaceæ*.

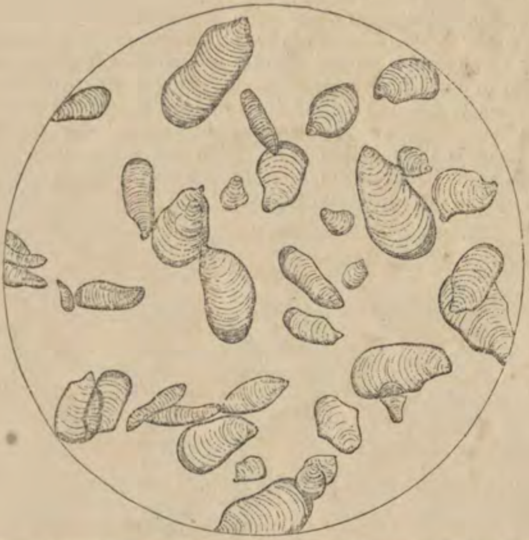
The mode of its preparation does not differ materially from that practised in obtaining the fecula from the tubers of *Maranta arundinacea*, and which has already been described.

Two qualities of Curcuma arrowroot are imported into this country from the East Indies, principally from Calcutta, a white and a brown variety.

The white is the best; the powder, when pressed between the fingers, feels less firm, and does not crepitate to the same extent as Maranta arrowroot; the two species can, however, be distinguished from each other only with certainty by means of the microscope.

Examined with that instrument, the granules appear elongated, and are irregularly ovate; being flat, they present but little lateral shading; the lines which mark the surface are tolerably distinct, but they describe segments of circles only, and the hilum, which is usually very indistinct and sometimes invisible, is placed at the narrow extremity of each granule. In size the particles vary considerably, but many of them much exceed the largest contained in Maranta arrowroot.

Fig. 109.



CURCUMA arrowroot, commonly denominated East India arrowroot. Drawn with the Camera Lucida, and magnified 240 diameters.

Curcuma arrowroot, therefore, is distinguished from Maranta arrowroot by the size and form of the granules, the position of the hilum, and the incomplete rings seen on the surfaces of the granules. Curcuma arrowroot is commonly called East India arrowroot, the same name being sometimes applied to Maranta arrowroot cultivated in the East, and sent to this country; we have thus two distinct species of arrowroot, of different qualities and value, confounded together under one name.

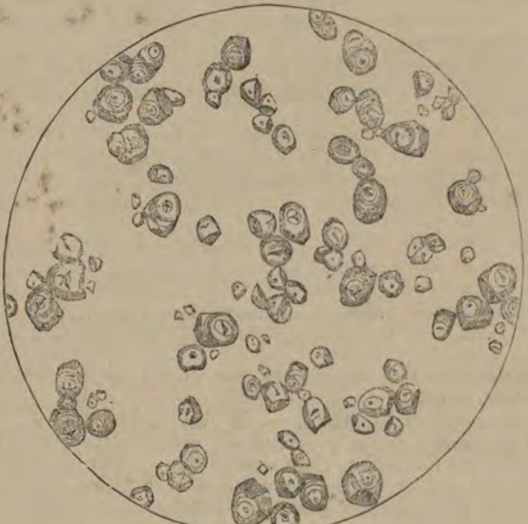
TACCA ARROWROOT.

Tacca arrowroot is obtained from the tubers of *Tacca oceanica*, a native of the South Sea Islands, after the chief of which, Tahiti or Otaheite, it is usually designated.

According to Ellis*, it grows on the high sandy banks near the sea, or on the sides of the lower mountains.

In Pereira's "Elements of Materia Medica" the following account is given of the preparation of the fecula:—"At Tahiti this is procured by washing the tubers, scraping off their outer skin, and then reducing them to a pulp by friction on a kind of rasp, made by winding coarse twine (formed of the cocoa nut fibre) regularly round a board.† The pulp is washed with sea water through a sieve, made of the fibrous web which protects the young frond of the cocoa nut palm. The strained liquor is received in a wooden trough, in which the fecula is deposited; and the supernatant liquor being poured off, the sediment is formed into balls, which are dried in the sun for twelve or twenty-four hours, then broken and reduced to powder, which is spread out in the sun to dry."

Fig. 110.



TACCA arrowroot, called usually Tahiti or Otaheite arrowroot. Drawn with the Camera Lucida, and magnified 220 diameters.

Tacca arrowroot is a white, starch-like powder, having a slightly musty odour. The granules resemble somewhat those of sago meal, but are very much smaller; when viewed sideways, they are muller-shaped, with truncate or dihedral bases, and when seen endways they appear circular, and occasionally angular or polyhedral. The rings are few and indistinct, and the hilum circular, sometimes fissured in a stellate manner.

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* Polynesian Researches.

† Ellis states that the rind of the root is scraped off by a cowry shell, and the root then grated on a piece of coral.

Tacca arrowroot has been sold in London for some years, in packages, as "arrowroot prepared by the native converts of the missionary stations in the South Sea Islands." It is sometimes spoken of as "Williams's arrowroot," after the missionary of that name.

The slightly musty odour which it usually possesses shows that it is not in general prepared with quite the same amount of care as is bestowed on Maranta arrowroot.

Manihot Arrowroot.

The flour or farina of *Manihot utilissima*, the plant which yields "tapioca," is sometimes imported into this country, under the name of "Brazilian arrowroot."

To the application of the word arrowroot to the fecula of this plant there exists no objection, since it resembles closely the other arrowroots in its properties.

The description of *Manihot utilissima*, the Cassava or tapioca plant, and of the manner in which the fecula is first obtained, and subsequently converted into the substance called tapioca, we shall reserve until we come to treat, in a distinct report, upon "Tapioca and its Adulterations."

Manihot arrowroot, like the other kinds already described, may be distinguished by the size, form, and other characters of its constituent granules, which resemble somewhat closely those of Tacca arrowroot, but are considerably smaller, with a larger proportion of granules, which exhibit a circular outline, as seen in the field of the microscope: the hilum is usually fissured.

The price of tapioca to the public varies from 6*d.* to 10*d.* the pound; now, as greater time and labour are expended in the manufacture of this substance than is required for the preparation of the arrowroot, the price of the latter ought to be still less than this.

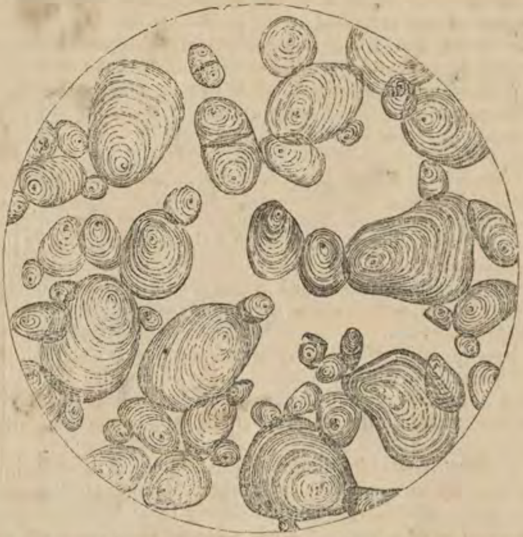
Potato Arrowroot.

Potato flour, or arrowroot, sometimes called *British* or *English* arrowroot, is prepared by rasping and grinding the well cleansed tubers of *Solanum tuberosum* into a pulp. This is repeatedly washed, and the water strained through a sieve, which contains the cellular tissue, and allows the starch to pass through. After a time the starch is deposited at the bottom of the vessel, is again well washed, and finally dried.

Potato starch forms a white and somewhat glistening powder, which crackles like genuine Maranta arrowroot when pressed between the fingers.

The granules vary greatly in size and shape: some are very small and circular, others large, ovate, or oyster shaped. The larger granules exhibit numerous very distinct concentric rings, and the hilum, which is small, but well defined, is situated in the narrow extremity of each granule: not unfrequently granules may be observed of an oval form, divided by a fine line into two portions or segments, each of which is provided with a hilum. We have noticed the same compound granule in some of the other arrowroots, particularly the Tacca species.

Fig. 111.



POTATO arrowroot, commonly called British arrowroot. Drawn with the Camera Lucida, and magnified 240 diameters.

The granules of potato arrowroot differ from those of the previously described starches, in their larger size, in their form, and in the number and distinctness of the concentric rings which each granule presents to view.

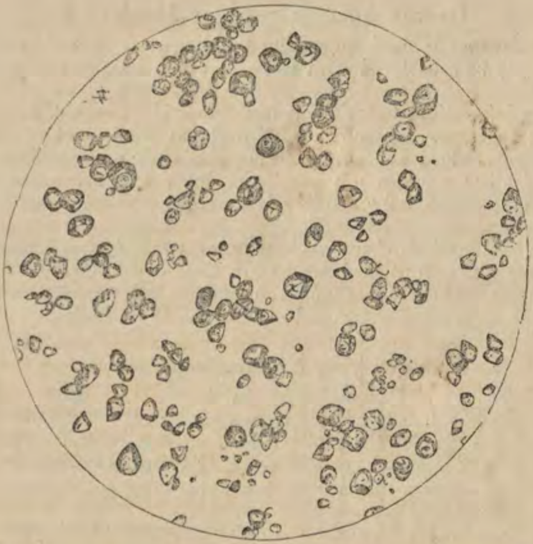
No means exist by which potato arrowroot may be distinguished so satisfactorily as by the microscope; yet it is proper to state, it has been observed that this substance is acted upon by certain reagents in a manner different from Maranta arrowroot: Mixed with twice its weight of concentrated hydrochloric acid, Maranta arrowroot yields an opaque paste; whereas that formed with potato arrowroot is transparent and jelly-like. When boiled with water and sulphuric acid the latter evolves a peculiar and somewhat disagreeable odour, which is not the case with the former, when treated in the same manner. Lastly, alcohol extracts from potato flour an acrid oil, not contained in the fecula of Maranta plant.

Potato arrowroot is the cheapest of all the starches regarded as arrowroots, the retail price varying from 4*d.* to 6*d.* per pound. Although a cheap and useful article of diet, it is of course inferior to Maranta arrowroot.

ARUM ARROWROOT.

Arum arrowroot is procured from the tubers of *Arum maculatum*, the common "cuckoo pint," "wake robin," and "lords and ladies:" it is prepared chiefly in Portland island; hence it is generally called "Portland arrowroot."

Fig. 112.



ARUM arrowroot, commonly called "Portland arrowroot." Drawn with the Camera Lucida, and magnified 240 diameters.

The mode of its preparation is very similar to that adopted with the other arrowroots; the tubers are pounded in a mortar, the pulp repeatedly washed, and the water subsequently strained. As the tubers are very acrid, great care is required in the washing and straining of this arrowroot, so that the acridity may be completely removed.

The starch granules of Arum arrowroot are very small, and, except in size, they resemble very closely those of Tacca arrowroot; but this difference is sufficiently constant and considerable to ensure the ready identification of the two kinds.

Strictly speaking, the word arrowroot may be applied to every pure starch, that is, every article consisting only of starch the produce of one plant. Now pure starch may be obtained from nearly any grain or plants containing starch in considerable amount, as from *wheat*, *rye*, *maize*, *rice*, &c.; hence we may have arrowroot procured from each of the grains named as well as a variety of others.

A very excellent *arrowroot* has recently been made from *Indian corn*, and is sold under the name of "*Oswego Prepared Corn.*"

ON THE ADULTERATIONS OF ARROWROOT.

As arrowroot is used in making puddings, cakes, &c., its adulterations may be considered with those of other articles of the dinner table.

The adulterations to which arrowroot is subject consist, first, in the mixing together of arrowroots of different kinds and of different commercial value; and, second, in the admixture with genuine arrowroot of other starches not usually recognised as arrowroot, and of low price: occasionally starches not arrowroots are substituted for arrowroot.

The adulterations of arrowroot are usually practised at home. From evidence kindly furnished me by Mr. Day, of Old Cavendish Street, it appears, however, that not unfrequently it is mixed with inferior starches, as those of potato and sago, in the West Indies.

Results of the Examination of Samples.

Of *Fifty* samples of arrowroot subjected to microscopical examination, no less than *twenty-two* were adulterated.

In *sixteen* samples the adulteration consisted in the addition of a single article, much cheaper in price, and very inferior in quality, to genuine arrowroot, this, in ten instances, being *potato flour;* in five, *sago meal;* and in one case *tapioca starch.*

In *five* samples it consisted in the employment of two different articles, *potato flour* and *sago meal.*

In *two* instances three different starches were employed in the adulteration —viz., *potato flour*, *sago meal*, and *tapioca starch* or fecula.

Ten of the arrowroots *contained scarcely a particle of genuine Maranta or West Indian arrowroot*, for which they were sold. *One* consisted almost entirely of *sago meal; two* of *potato flour* and *sago meal;*

two of *potato flour*, *sago meal*, and *tapioca starch*; *one* of *tapioca starch*; and *four* were composed entirely of *potato arrowroot* or starch.

On the Detection of the Adulterations of Arrowroot.

The adulterations practised upon arrowroot are all of them readily discoverable by means of the microscope.

The structure and characters of potato starch have already been described and figured at p. 320.; those of sago are so at p. 325., and of tapioca at p. 329. The granules of sago starch are of considerable size, either ovate or more usually somewhat muller-shaped, rounded at one extremity, the other being truncated or else terminating in a dihedral summit; the hilum is placed in the larger and rounded part of the granule, is usually surrounded by a distinct ring, and is circular, cracking frequently in a radiate manner.

The strong inducement which exists to substitute potato starch and sago meal for the better descriptions of arrowroot will be evident when it is known that these starches may be purchased wholesale at something like 2*d.* per lb., while as much as 2*s.* 6*d.* and even 3*s.* 6*d.* is charged for the articles so often falsely denominated West India arrowroot.

It thus appears that, in the useful article arrowroot, the public is extensively defrauded of its money, and the revenue of its income.

The duty on arrowroot has been recently reduced; it is now only 4½*d.* per cwt., whether from a foreign or British possession, being the same duty as is paid on all kinds of flour and meal.

The quantity of this article imported was, in 1854, 14,905 cwts.; in 1855, 12,442 cwts. Retained for home consumption in 1854, 16,334 cwts.; and in 1855, 13,088 cwts.

SAGO, AND ITS ADULTERATIONS.

THE farinaceous substance *sago* is obtained from the stems of several palms: that which reaches this country is mostly derived from species belonging to the genera *Sagus* and *Saguerus*.

Of the genus Sagus there are two species, *S. lævis* and *S. gemina*.

Sago lævis inhabits the islands of the Indian Archipelago, Sumatra, and Borneo, growing spontaneously in low, swampy lands.

Roxburgh ("Flora Indica") states that from the pith of this tree "the granulated sago we meet with in Europe is made."

"A large quantity of granular sago is prepared from this species, in Sumatra especially, the peninsula of Malacca, and in Borneo. It is chiefly exported to Europe, Bengal, and China. The farina which is brought from Liak on the northern coast of Sumatra, although inferior in whiteness to that of Borneo, is much sought after on account of its being less friable. It commonly fetches twice the price of the latter."—*Pereira.*

It does not appear from Pereira whether any of the sago obtained from S. gemina reaches this country. "This, the Malay sago palm, is the tree, the pith of which is the staff of life to the inhabitants of the Moluccas."—*Roxburgh.*

Sago of good quality is also obtained from *Saguerus saccharifer*, an inhabitant of the same localities as the other palms mentioned. Whether it is ever imported into this country we know not.

The sago of commerce is brought to England from Singapore in bags.

It exists in the forms of raw sago meal, sago flour, and granulated sago.

Raw sago meal is procured in the Moluccas as follows:—When sufficiently mature the tree is cut down near the root, divided into pieces six or seven feet long, each of which is split down the middle; the pith is then extracted, and, with an instrument of bamboo or hard wood, is reduced to powder like sawdust; it is mixed with water, and the mixture strained through a sieve which retains the cellular tissue of the pith. The strained liquor contains the farina, which, after being deposited, is washed once or twice, and is then fit for use.

Granulated sago is prepared by mixing the meal with water, and so converting it into a paste, which is then granulated usually by passing it through a sieve. In most cases the granules as they fall from the sieve are received into a shallow heated iron vessel, so that they are partially baked.

Sago flour is prepared from sago meal by repeated sifting and washing; it is also usually bleached by means by chloride of lime.

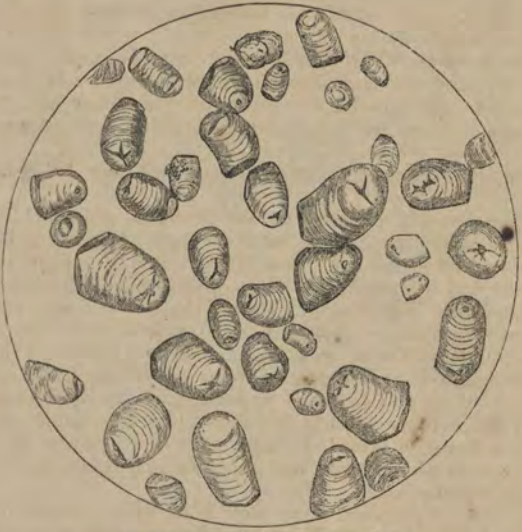
The farina or starch of sago, examined with the microscope, is seen to consist of granules of considerable size and elongated form, being usually rounded at one end which is the larger, and, owing to the mutual pressure of the particles, truncate at the other extremity. Sometimes the fucette is single, when the granules are more or less muller-shaped; in others there is double fucette: the hilum, when perfect, is circular; but it is often cracked, when it appears as a slit, cross, or star. Surrounding the hilum, a few indistinct rings may usually be perceived in some of the granules. Examined with the polariscope, the particles usually exhibit a black cross, the hilum being the centre.

Granulated sago is met with in two states, common or *brown*, and *pearl*; and of each of these kinds there are several kinds, differing in the size and colour of the grains. In all, the starch granules differ much from those of raw sago; they are much larger and less regular, effects due to the heat employed in the preparation of granulated sago.

ON THE ADULTERATIONS OF SAGO.

The principal adulteration of sago flour and of granulated sago is with potato starch. Usually a factitious sago prepared from potato starch is substituted for true sago.

Fig. 113.



SAGO *Starch.* Magnified 225 diameters.

Pereira has the following remarks in relation to factitious sago:— "This is prepared in both Germany and in France, at Gentilly near Paris, with potato starch. It occurs both white and coloured.

"I have two kinds of white factitious sago, one small grained, the grains of which are scarcely so large as white mustard seeds; the other large grained, the grains of which are intermediate in size between white mustard seeds and coriander seeds. The first I met with in English commerce; for the other I am indebted to Professor Guibourt.

"I have also two kinds of coloured factitious sago, both large grained; one red *, the other brownish †, and somewhat resembling brownish pearl sago."

Pereira also states that he received from Prof. Guibourt samples of "Sagou des Maldives de Planche donné par lui," and "Sagou de la Nouvelle Guinée donné par lui," and that he found them to be

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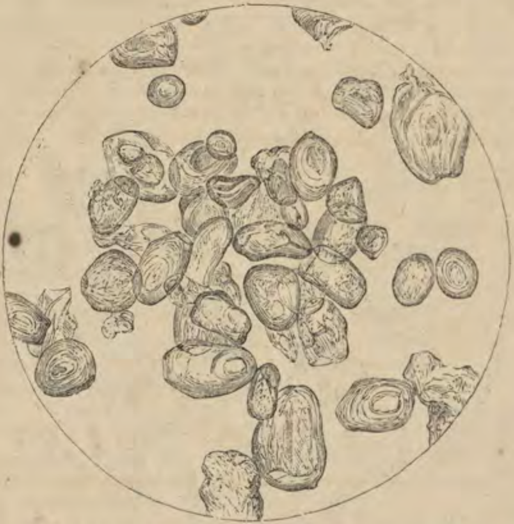
* "This is perhaps the kind mentioned by Planche, as being falsified sago coloured with cochineal."

† "This is perhaps the brown sort of German sago made from potato starch, and said by Dierbach to be coloured with burnt sugar."

Fig. 114.



Starch granules of Sago, altered by heat, as in making *granulated sago.* Magnified 225 diameters.

factitious sagos prepared from potato starch. The grains of the New Guinea sago were bright red on one side and whitish on the other.

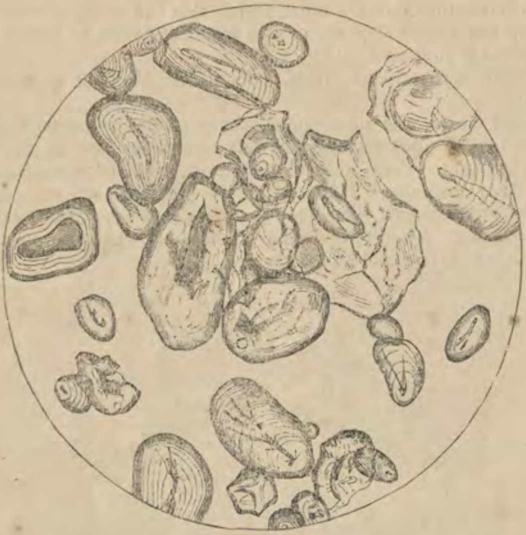
Of *thirty* samples of granulated sago submitted to examination, *five* were found to be *factitious*, and to consist of *potato flour.*

On the Detection of the Adulterations of Sago.

The microscope can alone detect the adulterations of sago flour and granulated sago, and especially distinguish factitious from genuine sago. The characters of sago starch have already been described and figured, as also have those of potato at p. 320.; in granulated sago, whether true or false, the granules are of course much altered; those of potato are swollen, irregular in shape, sometimes ruptured, and the striæ effaced, &c.

Import duty, 4½*d.* per cwt. Quantities imported: 1854, 128,789 cwts.; 1855, 92,800 cwts. Home consumption: 1854, 121,046 cwts.; 1855, 108,499 cwts.

Fig. 115.



Factitious sago, composed of *potato flour*. Magnified 225 diameters.

TAPIOCA, AND ITS ADULTERATIONS.

The articles known as Cassava meal and bread, Cassava, Tapioca or Brazilian arrowroot and Tapioca, are obtained from different species of the genus *Manihot*, one of the *Euphorbiaceæ*. One of these is *M. utilissima*, the bitter Cassava, a native of the Brazils, where, as well as in other parts of South America, it is cultivated.

The starch is associated in the large tuberous root with a poisonous milky juice containing hydrocyanic acid and a bitter acrid principle.

Another species is *Manihot Aipi*, or sweet Cassava, the juice of the root of which is not poisonous.

A third species is *M. Janipha*, the root of which is also devoid of poisonous properties.

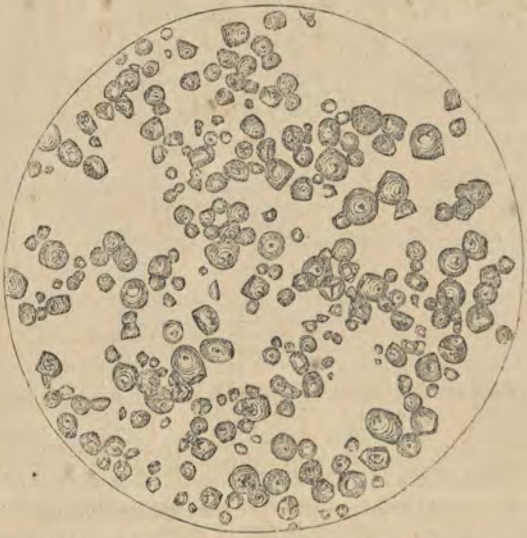
Cassava meal is prepared as well from the bitter or poisonous species as the sweet and innocuous: the root is grated, and the pulpy mass subjected to pressure to get rid of the juice: the residue, dried and pounded, constitutes Cassava meal, and of this the bread is made.

The expressed juice deposits after a time the farina or starch, from which tapioca is prepared.

This farina, washed and dried, constitutes Manihot or Brazilian arrowroot.

Examined under the microscope, the granules are seen to be of small size, for the most part single, but sometimes and in the plant itself always united into compound grains, each composed of two, three, or four granules. Hence, like those of sago, they are usually muller-shaped, although when seen endways they appear circular; the hilum is distinct. No differences have been observed in the characters of the starch of bitter and sweet Cassava.

Fig. 116.



Starch granules of MANIHOT UTILISSIMA, or *Tapioca*. Magnified 225 diameters.

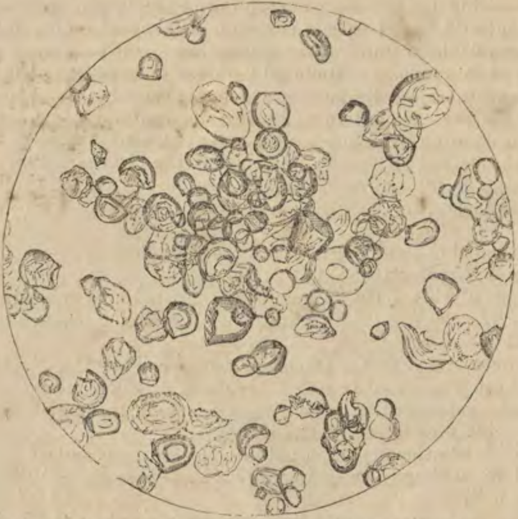
Manihot arrowroot is usually imported into this country from Rio Janeiro.

In the manufacture of tapioca, the meal while moist is heated, and then dried on hot plates: this treatment of course causes the starch granules to swell, and many of them to burst; they at the same time adhere together in small irregular masses.

ON THE ADULTERATIONS OF TAPIOCA.

Manihot arrowroot or starch is occasionally adulterated by admixture with other starches, as those of *sago* and *potato*.

Fig. 117.



Starch granules of *Tapioca*, altered by the heat employed in its preparation. Magnified 225 diameters.

Of *Twenty-three* samples of tapioca examined, *two* were ascertained to consist of *sago*, and *one* of *potato starch*.

Manihot starch is more frequently used as an adulterant, especially of Maranta arrowroot, than is itself adulterated.

On the Detection of the Adulterations of Tapioca.

The only means of detecting the adulterations of Manihot arrowroot, and of tapioca, is furnished by the microscope: with that instrument their detection is rendered easy and certain. The characters of *sago starch* are described and figured at p. 325., and those of *potato starch* at p. 320.

Import duty, same as Sago, Arrowroot, and Flour, 4½*d.* per cwt.

Quantities imported: 1854, 3,501 cwts.; 1855, 4,473 cwts. Home consumption: 1854, 4,444 cwts.; 1855, 4,305 cwts.

PROPRIETARY ALIMENTARY PREPARATIONS.

The articles referred to under the above head being proprietary, and there being no recognised receipts or formularies for their composition, they do not properly come under the head of articles of consumption liable to adulteration. Nevertheless, the public will doubtless be glad to be made acquainted with the composition of the chief of these articles, especially those which are described as being possessed of almost miraculous powers of curing disease, and which are sold under certain high sounding names, and at exorbitant prices. Until the microscope was applied by ourselves to the discrimination of different vegetable substances, it was not possible to have determined, by any known means, the composition of many of the preparations about to be noticed.

The principal of these preparations are the following:—

Wharton's Ervalenta. Sold at 2*s.* 9*d.* per lb.

A sample of this article, examined, consisted of a mixture of *the French* or *German lentil*, with a substance resembling *maize*, or *Indian corn meal.*

It has been stated that the farina of a grass called "Dari," "Durra," &c., has been discovered in either Ervalenta or Revalenta.

We have succeeded in procuring a sample of this article, and find it to resemble very closely maize in structure.

"Dari" is occasionally imported into this country, and sold at about twenty-four shillings per quarter, that is, at the rate of rather more than one halfpenny per pound.

We received from Dr. Pereira some time previous to his decease, the following information respecting "Durra."

"*Dari,* I suspect means *Durra,* also spelt *Doura, Dora,* &c. It is a corn used by the Arabs, and is cultivated in the south of Europe. It is the *Holcus durra sativus* of Förskäl, the *Sorghum vulgare* of some other writers.

"Its meal is said to resemble that of Indian corn. Now it deserves notice, that a German microscopist recently stated that he found the meal of Indian corn in *ervalenta,* or *revalenta,* I forget which. Did he mistake it for the Sorghum?"

For description and figure of Durra, see pp. 289—292.

Du Barry's Revalenta. Sold at the same rate as the Ervalenta.

Three samples of this article were examined: one consisted of a mixture of the *red* or *Arabian* lentil and *barley flour;* the second, of the same ingredients mixed with *sugar;* and the third sample consisted of the *Arabian lentil* and barley flour, with the addition of saline matter, chiefly *salt;* it also possessed a peculiar taste, as though flavoured with *celery seed.*

Butler & M'Culloch's Prepared Lentil Powder, 1*s*. 6*d*. per lb., was found to consist entirely of the *French or German lentil.*

Edwards Brothers' Arabian Revalenta, 1*s*. per lb., was ascertained to consist of *lentil powder*, probably of the yellow and red lentil mixed.

Nevill's Patent Flour of Lentils, 1*s*. per lb.

Two samples of this article were examined: one consisted of the *red lentil* and *wheat flour*, and the other of the same species of *lentil* and *barley flour.*

Lentils belong to the natural family of plants, *Leguminosæ*, which includes the several kinds of beans and peas; they resemble, to a very great extent, in colour, structure, taste, and properties, the common pea; so great, indeed, is the similarity in organisation, that it is difficult to discriminate between them, even by the aid of the microscope.

Lentils, peas, beans, &c., all contain a considerable amount of nitrogenised matter, in the form of *Legumine;* when taken as an article of diet, they are found by most to be somewhat difficult of digestion, to occasion distension and flatulency, and to be slightly aperient. These properties and effects are so similar in the case of each, that it is almost impossible to draw any decided line of demarcation between them.

"Purified lentils" are prepared under a patent, by Mr. Nevill, who formerly supplied Du Barry and Co. with the article, at 10*l*. per ton; that is, at about one penny and a fraction per pound.

The admixture of barley and other flours with lentil powder is not to be regarded in the light of an adulteration, since the cost of barley flour exceeds that of the lentil, being about 13*l*. per ton.

The object of this mixture is chiefly to diminish the strong flavour of the lentils, and which is so disagreeable to many. Messrs. Du Barry and Co. still more effectually accomplished this object, in some cases, by the addition of sugar.

Extremes meet: lentils, being somewhat cheaper than peas, are supplied to many of our workhouses, to be used in the preparation of soup, &c. Thus they are not only consumed by paupers, but by the rich, the chief difference being, that the latter frequently pay 2*s*. 9*d*. per pound for them.

As the cost of most of the prepared lentil powders, sold as Ervalenta, Revalenta, &c.—viz., 2*s*. 9*d*. per pound—forms a very serious obstacle to their use, supposing that in any respect it is desirable that they should be more generally consumed, we have framed the two following receipts, whereby a considerable saving of expense may be effected:—

1st *Receipt.*

Red or Arabian lentil flour - - -	2 lbs.
Barley flour - - - - -	1 lb.
Salt - - - - - -	3 oz.

Mix into a uniform powder.

The red lentil may be obtained of almost every corn chandler, at about 4*d.* per quart; the cost of a pound of *our* Ervalenta would be about 2*d.* per pound; and it is perfectly clear, from the analyses which we have given above, that whatever may be the advantages possessed by the much-vaunted Ervalentas, Revalentas, &c., that our article must contain them all.

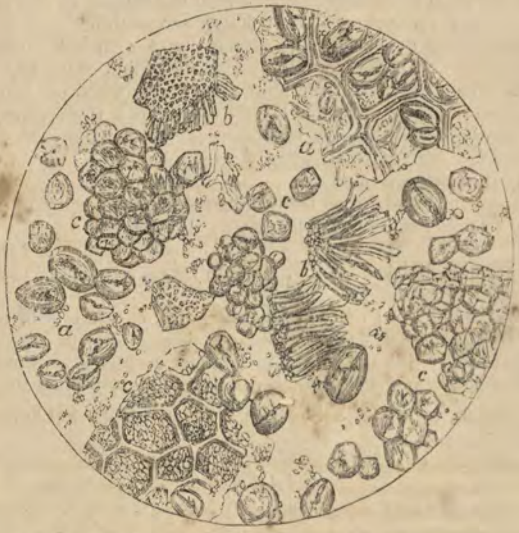
2nd Receipt.

Pea flour - - - - -	2 lbs.
Indian corn flour - - - -	1 lb.
Salt - - - - - - -	3 oz.

Mix as before.

The characters of lentil flour, and the composition of Ervalenta, Revalenta, and of Leath's Alimentary Farina are exhibited in the following engravings.

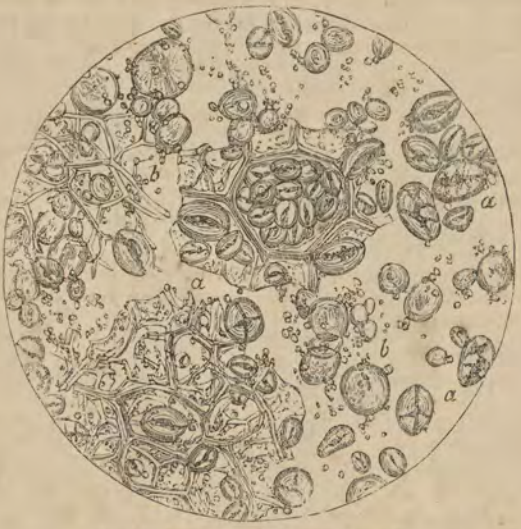
Fig. 118.



Sample of WHARTON'S ERVALENTA, as it appears under the microscope.
a a, starch corpuscles of the FRENCH LENTIL; *b b*, fragments of the husk; *c c*, starch granules and masses of the substance resembling INDIAN CORN MEAL.

Being satisfied that lentils and peas do not differ in their properties to any great extent, we have devised the above receipt to

Fig. 119.



Sample of Du Barry's REVALENTA ARABICA.

a a, starch granules of the ARABIAN LENTIL, some loose, others lying in the cells of the cellulose; *b b* starch granules of BARLEY FLOUR.

meet those cases in which any difficulty may be met with in procuring the red lentil, which however is now very commonly kept by corn chandlers.

From the several preparations of lentil flour noticed, we will pass to describe certain other

Farinaceous Foods.

Gardiner's Alimentary Preparation consisted of very finely ground *rice*.

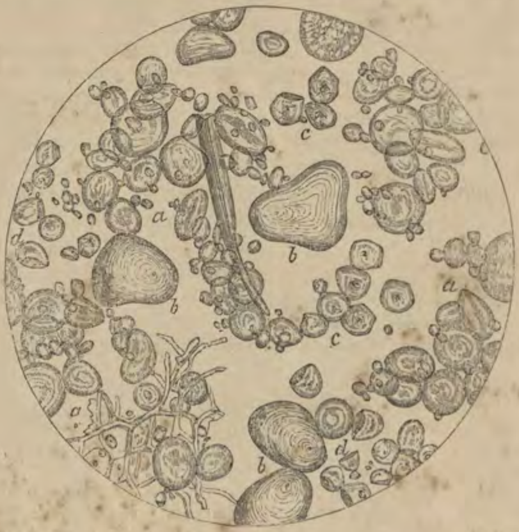
Leath's Alimentary Farina, or *Homœopathic Farinaceous Food*, consisted principally of *wheat flour*, slightly baked, sweetened with *sugar*, together with *potato starch*, *Indian corn meal*, and *tapioca*.

Semolina consists in some cases of the gluten of wheat mixed with a proportion of wheat flour; in others, of certain descriptions of wheat flour only, rich in gluten.

Semolina is not a proprietary article.

Bullock's Semola consists of the *gluten of wheat* with a proportion of *wheat starch*. This is an excellent preparation.

Fig. 120.



Leath's Alimentary Farina, or Homœopathic Farinaceous Food.
a a, starch granules of Wheat : *b b*, starch corpuscles of Potato ; *c c*, ditto of Indian corn Meal ; *d d*, ditto of Tapioca.

Prince Arthur's Farinaceous Food was composed entirely of *baked wheat flour*.

The Prince of Wales's Food was composed entirely of *potato flour*.

Hards' Farinaceous Flour, of *wheat flower, baked*.

Maidman's Nutritious Farina consisted entirely of *potato flour* artificially coloured of a pink or rosy tint, the colouring matter being probably *rose pink*.

Braden's Farinaceous Food consisted of *wheat flour, baked*.

Baster's Soojie was composed of *wheat flour*, sweetened with *sugar*.

Baster's Compounded Farina possessed *a similar composition*.

Jones's Patent Flour, consisted of *wheat flour, tartaric acid*, and *carbonate of soda*.

Plumbe's Improved Farinaceous Food was composed of *bean* or *pea flour*, with a little *Tacca arrowroot*, some *potato flour*, and a very little *Maranta arrowroot*.

Lastly, *Palmer's Vitaroborant* consisted of a mixture, sweetened with sugar, of the *red* or *Arabian lentil* and *wheat flour*.

The public is now in a position to judge of the degree of relation which exists between the high-sounding titles bestowed on many of the preparations noticed in this Report, their actual composition, and the properties, so loudly vaunted, alleged to be possessed by them; it will also be able to judge somewhat of the extent to which the pocket is made to suffer through these health restoring, life prolonging, easily digestible articles and compounds.

ON THE DETECTION OF THE COMPOSITION OF PROPRIETARY ALIMENTARY PREPARATIONS.

In the majority of cases the only means by which the composition of these articles is to be determined is afforded by the microscope. By this instrument the starches of the several flours and arrowroots of which they are composed can all be identified. The characters of nearly all these have already been described and figured.

ANCHOVIES, THEIR SUBSTITUTIONS AND ADULTERATIONS.

THE next articles of the Breakfast Table to the adulterations of which we desire to direct attention are Anchovies, and Potted Meats and Fish.

We find but little, in works on the adulteration of food, in reference to the substitution of inferior kinds of fish for this much esteemed variety; although, if common report is to be credited, but few articles of consumption are more subject to substitution and adulteration than the anchovy, whether in the entire state or in the forms of paste and sauce.

On the present occasion we have to treat of the entire fish only.

Before proceeding to give the results of the examination and analyses of various samples of anchovies, as vended in the metropolis, we insert an original figure, as also a scientific description, of the fish, taken from Yarrell's excellent work on the British Fishes.

" *Generic Characters.* —Distinguished from the herring in having the head pointed: the upper jaw the longest; the mouth deeply

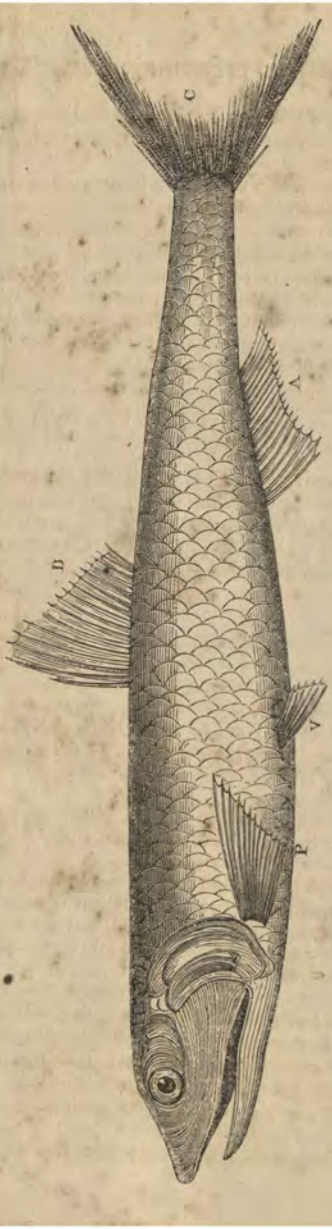


Fig. 121.

THE TRUE ANCHOVY. *Engraulis encrasicolus*, FLEMING.

D, dorsal fin; P, pectoral fin; V, ventral fin; A, anal fin; C, caudal fin.

divided; the opening extending backwards behind the line of the eyes; the gape branchial apertures very large; the ventral fins in advance of the line of the commencement of the dorsal; abdomen smooth; branchiostegous rays twelve.

"I have followed Dr. Fleming, in preserving to the anchovy the old name by which it was formerly known. It was called *Lycostomus*, from the form of its mouth; and *Engraulis encrasicolus*, because, from its bitterness, it was supposed to carry its gall in its head. For this reason, the head, as well as the entrails, are removed when the fish is pickled.

"The anchovy is a common fish in the Mediterranean, from Greece to Gibraltar, and was well known to the Greeks and Romans, by whom the liquor prepared from it, called *garum*, was in great estimation. Its eastern range is extended into the Black Sea.

"The fishing for them is carried on during the night, and lights are used with the nets.

"The anchovy is common on the coasts of Portugal, Spain, and France; it occurs, I have no doubt, at the Channel Islands, and has been taken on the Hampshire coast, and in the Bristol Channel. In the Appendix to Willughby's work, it is mentioned as having been taken on the coast of Wales; Pennant obtained it near his own residence, at Downing in Flintshire; and Mr. Bicheno has very recently obtained several on the coast of Glamorganshire. It is said to be sold frequently in Liverpool market, and is reported to be at this time an inhabitant of the piece of water below Blackwall, called Dagenhall Reach.

"Its range to the north is extensive, as it is occasionally taken in the Baltic, and on the coast of Norway; but is not included by Linnæus in his *Fauna Suecica.*

"The anchovy appears to attain a much larger size than has usually been accorded to it: from four to five inches in length is the more ordinary size; but Mr. Couch says, 'I have seen it in the Cornish seas of the length of seven inches and a half; and I have met with specimens from autumn, through the winter, to the middle of March. It is therefore probable that a fishery might be established with good prospect of success, for though the nets employed for other fish can take but few of them, the numbers found in the stomachs of the whiting, and other ravenous fishes, show that they are in considerable abundance.

"The anchovy is immediately recognised among the species of the family to which it belongs by its sharp-pointed head, with the upper jaw considerably the longest. The length of the head, compared with the length of the body alone, is as one to three; the depth of the body but two thirds of the length of the head, and compared to the length of the whole fish, is as one to seven; the first ray of the dorsal fin arises half way between the point of the nose and the end of the fleshy portion of the tail; the third ray of the dorsal fin, which is the longest, is of the same length as the base of the fin; the pectoral fin small; the ventral fins arise in a vertical line in advance of the commencement of the dorsal fin, which is over the space between the ventral and anal fins; the base of the anal fin is as long as the distance from its commencement to the origin of the ventral fins; the rays short; the tail deeply forked. The fin rays in number are —

D, 14; P, 15; V, 7; A, 18; C, 19.

The breadth of the eye is one fifth of the length of the whole head; the peculiarity in the comparative length of the jaws has been previously noticed; the gill covers are elongated; the scales of the body large and deciduous; the colour of the top of the head and back blue, with a tinge of green; irides, gill covers, sides, and belly, silvery white; the fins delicate in structure, and greenish white; the membranes connecting the rays almost transparent.

"In a series of notes on the occurrence of rare fish at Yarmouth and its vicinity, with which I have been favoured by Dawson Turner, Esq., there is mention of a specimen of the anchovy, taken on the beach, which measured six inches and a half in length; an additional proof of the large size acquired by this fish on our shores."

To the above we would add a description of the condition of the true anchovy when bottled.

The head and intestines are removed; the scales and fins, with the exception of the pectorals, are allowed to remain; the fish is of small size, silvery, and rather flat, the line of the back slightly curved, and the flesh is usually of a pink or salmon colour, the depth varying considerably in different samples according to age: if an anchovy be three months old, it will be pale; if six months, rather pink; and if twelve months, a beautiful deep pink colour.

The number of the fin-rays, which may be counted in the fish in its preserved state, is greater than that given in the description we have quoted; thus, when complete, the dorsal fin is composed of sixteen rays, the anal fin of nineteen, and the caudal of twenty-six rays.

Anchovies are imported in barrels, and are preserved in brine made with rock salt; the bottling is performed in this country, chiefly by wholesale pickle and fish-sauce makers.

ON THE ADULTERATIONS OF ANCHOVIES.

Several kinds of fish are either substituted for, or mixed with, the genuine Gorgona anchovy.

The chief of these are *Dutch*, *French*, and *Sicilian Fish*, and occasionally *Sardines* and *Sprats*.

In addition, the brine in which the first are preserved is almost invariably highly coloured with large quantities of *bole Armenian* and *Venetian red*.

Bole Armenian is a red ferruginous earth, often prepared artificially by mixing together Venetian red and chalk. The reason of its being added to anchovies, it is alleged, is to improve the appearance of the fish; but the real reason is to conceal the dirt contained in the brine which surrounds the fish.

In eating anchovies some persons first wash the fish, by which means they no doubt get rid of much of the red earth and dirt; but others eat the fish just as it comes out of the brine.

From an examination of *twenty-eight* samples of anchovies, mostly in bottles, it appears,

That *seven* of the samples consisted entirely of DUTCH FISH.

That *two* consisted of a mixture of DUTCH FISH and Anchovies.

That the brine in *twenty-three* of the samples was charged with either *bole Armenian* or *Venetian red*, the quantity varying considerably in amount; but in most cases the brine was saturated with these earthy powders to such an extent that they might be obtained and collected from the bottom of the bottles almost by teaspoonfuls.

It is not to be inferred that those samples in which no Dutch fish were detected, consisted of the true anchovy, since we have ascertained that two other kinds of fish besides the Dutch are commonly imported and sold as "true anchovies," and "real Gorgonas," — namely, French and Sicilian fish.

Now, we have no doubt but that the majority of the above samples consisted entirely of one or other of these fish; we hesitate, however, to pronounce a positive opinion in each case. Although it is not difficult to distinguish French and Sicilian fish from the Gorgona anchovy, when first taken from the barrels in which they are imported, yet when contained in bottles, the discrimination is often a matter of considerable difficulty, and in many cases is even scarcely possible. This arises from the squeezing and mutilation of the fish in the process of bottling, as well as from the altered appearance due to the red earthy matters with which they are commonly covered. Whether those engaged in the trade are acquainted with any practical characters by which the discrimination of the fish, even when thus altered, may be effected, we know not.

We have, however, much reason to think that Sicilian and French fish, notwithstanding their resemblance to the true anchovy, may be distinguished, by experienced persons, even when bottled. With a view to determine this point we forwarded to a person engaged in the anchovy trade, twelve of the samples referred to, each being labelled with a distinct number; the following is his Report: —

1. Gorgona.
2. French fish.
3. Ditto.
4. Gorgona, not fine.
5. Sicilian Fish.
6. Gorgona.
7. Dutch, inferior.
8. Sicilian, good quality.
9. Gorgona.
10. Dutch Fish.
11. Sicilian.
12. Sicilian, best quality.

If this list be correct, then NOT ONE THIRD OF THE TWENTY-EIGHT SAMPLES EXAMINED CONSISTED OF GORGONA ANCHOVIES.

The practice of imparting an unnaturally red colour to the fish and brine, by means of Venetian red and bole Armenian, is in the highest degree reprehensible. To saturate an article of food with large quantities of earthy colouring matter, is objectionable on the score of cleanliness; it is equally so as regards health, for this earth contains a large quantity of iron. Now, this medicine is not suited to all cases, and it may even, in some instances, be productive of mischief; at all events, when it is desirable to take iron, we should prefer that it be prescribed under the advice of a physician, and not administered in an article of food by our grocer, fishmonger, or Italian warehouseman.

Again, it occasionally happens that Venetian red contains red lead; and although, in the analyses we have made, we are happy to state that *we have not detected that poisonous metallic oxide in a single sample*, there is no question but that red lead is occasionally to be found in bottled anchovies.

Anchovies, even when thus coarsely reddened, and put up in glass bottles, are not particularly sightly objects. Both for convenience and appearance, it would be much better that they should be enclosed in open-mouthed earthen jars, which might be made of different patterns, and as ornamental as desired; by this means the necessity for colouring would be done away with, and there would be no occasion to use wax and resin, themselves frequently coloured with red lead, to coat the corks, and some of which substances, on the bottles being opened, usually find their way into the contents. Now that glass is so cheap, if bottles continue to be used, they should, at all events, be furnished with glass stoppers in place of corks.

On the Detection of the Adulterations of Anchovies.

The *Dutch* fish may be distinguished from the true anchovy, by its being invariably deprived of its scales, by its large size, white flesh, general coarseness, and by the very evident scale-marks which extend over the whole surface. The fins have the same disposition as the true anchovy, and the same number of rays ; and it is possible that this fish may be one of the genus *Engraulis*, of which there are three or even more species.

The French, and especially the Dutch, fish are not only of much less value, but also greatly inferior as articles of diet to the true anchovy. The difference in their cost may be estimated by the fact, that dealers find it worth their while to mix them in different proportions in even the same bottle. There is no difficulty in distinguishing the Dutch fish by the characters pointed out above; but it would be very difficult to discriminate between the larger samples of the French anchovies, when denuded of their scales, and that which in this article is denominated *Dutch fish*, and hence we infer that the two may possibly be separate states and conditions of one and the same species.

The *French Fish* is caught off the coasts of Nantz and Nice, and is imported into this country in barrels packed in brine made with rock salt.

It closely resembles in its characters the true anchovy, and is probably of the same genus. Like the anchovy, it is deprived of its head and intestines, but the scales, and not unfrequently the brachial rays and pectoral fins, are entire. Moreover, the fish is usually somewhat larger, thicker across the back, tapers more towards the tail, and the flesh is much whiter than the Gorgona anchovy. These differences, however, are not sufficiently marked in general, to allow of this fish, *when bottled*, being satisfactorily distinguished from the true anchovy by an ordinary observer. Its commercial value is about one half that of the Gorgona anchovy.

The *Sicilian Fish* resembles the Gorgona anchovy very closely, of which, by some, it is considered to be the young, it being smaller. Whether it be a state of that species, or of the same genus, we are not able to determine with certainty; its value is at least one third less than that of the Gorgona anchovy.

In none of the samples have we met with either *sprats* or *sardines*, although there is no doubt that both these fish have been, and are still occasionally, sold as real Gorgona anchovies. The sprat may be readily distinguished from the anchovy, by the dorsal fin which consists of seventeen rays, but more particularly by the position of the ventral fin, which is placed in a vertical line directly under the first dorsal fin-ray.

The sardine is a shorter and thicker fish than the anchovy; it has white flesh, and the relative position of the ventral and dorsal fins is different.

On the Detection of Venetian Red and Bole Armenian.—The presence of these earths is sufficiently indicated by the red colour of the brine, and by the colour and earthy character of the precipitate. In order to obtain them in a separate state, the fish should be repeatedly washed, the washings and the brine evaporated, the residue treated with water to dissolve out the salt, and then incinerated and weighed: finally the ash must be tested for iron and chalk according to the processes already given; that for iron at p. 102., and that for chalk at p. 101.

Anchovies and all fish are free of duty on importation, and no returns are taken.

POTTED MEATS AND FISH, AND THEIR ADULTERATIONS.

Potted meats and fish are adulterated, first, by admixture with substances added for the sake of bulk, weight, and cheapness; and second, with others designed to heighten their colour.

Thus they are sometimes adulterated with large quantities of *flour*, and in other cases, it is alleged, with even *chalk* and *plaster of Paris*.

Again, *sprats* and *other cheap fish* are often bruised up, and, after being seasoned, are sold either in the separate or mixed state for real Gorgona paste.

Lastly, the majority of these pastes are very commonly coloured with large quantities of *Venetian red* and *bole Armenian*.

RESULTS OF THE EXAMINATION OF SAMPLES.

Twenty-eight samples of potted meats and fish were examined, and with the following results : —

1st. That the samples of *Potted Tongue* and *Ham* were entirely free from adulteration.

2nd. That four out of the five samples of *Potted Beef* were artificially coloured by means of the red earth, *bole Armenian.*

3rd. That the whole of the samples of *Potted Bloaters* examined were highly coloured with the before-named earthy substance.

4th. That one of the samples of *Bloater Paste* was adulterated in addition with a large proportion of *starch* or *flour*, probably wheat flour boiled.

5th. That the entire of the samples of *Anchovy Paste* analysed were still more highly, and even vividly, coloured with very large quantities of *bole Armenian.*

6th. That two of the *Anchovy Pastes* were in addition adulterated with *flour;* one with a large per-centage of *wheat flour.*

7th. That of the twenty-eight samples of *Potted Meats* and *Fish* subjected to analysis, no less than twenty-three were more or less impregnated with the red earthy material, *bole Armenian.*

This picture of the adulteration of potted meats and fish is surely bad and disgraceful enough.

The difference in the appearance presented by the uncoloured samples, contrasted with those in which the bole Armenian had been added, was most striking, and usually sufficient to enable the observer to distinguish by the eye alone the samples to which this scandalous addition had been made. While in the one case the paste was of a pale pink, and perfectly natural hue, in the other the colour was such as the flesh, when pounded, of no fish or animal ever presents, it being of a deep, earthy, and brick red.

In a previous Report we showed that one of the principal reasons why artificial colouring matters are employed in the case of bottled anchovies, is to conceal the dirt contained in the brine in which the fish is imported. In the present instance there is not even this poor excuse; the only purpose served by the employment of the bole Armenian being to cause the potted articles to present a striking appearance, but one which at the same time is, in our opinion, most unnatural, and but little inviting.

In the case too of potted meats and fish, the colouring ingredients cannot, as in anchovies, in a measure be got rid of by washing; for since they are incorporated with the paste, they must be entirely consumed with the meat or fish.

That the practice of adding large quantities of coloured earthy substances to articles of diet is dirty, injurious to health, and, in some cases, even dangerous to life, cannot be doubted. The chief medicinal ingredient in bole Armenian is oxide of iron; this, although not dangerous, might in some instances be productive of prejudicial effects; but it sometimes happens that other red earths are used, and these as well as also occasionally, although rarely, bole Armenian itself, are contaminated with red lead. *For this poisonous substance each of the above twenty-eight samples have been separately analysed, without however, we are happy to state, a particle of it being discovered in a single instance.*

So long, then, as manufacturers continue to mix red earths with their potted meats and fish,—these delicacies of the table, as they are commonly considered, so often had recourse to by the gourmand and the invalid to rouse a flagging appetite,—so long we recommend the public to refrain from purchasing them.

The preparation of potted meats and fish is so simple, that every housekeeper may, with a pestle and mortar and proper seasoning, make them herself without difficulty.

Mr. Richardson, officer of the Local Board of Health of Newton Heath, near Manchester, gave the following evidence, before the Committee on Adulteration, in regard to the addition of *horseflesh* to potted meats, sausages, &c.:—

"We have in Newton five knackers' yards, and there is only one in Manchester. The reason is, that they have so much toleration in Newton; and it has been a source of great profit to them, because they have the means of selling the best portions of the horseflesh to mix with the potted meats.

"I can say for a fact, that the tongues of horses particularly, and the best portions, such as the hind quarters, of horses, are generally sold to mix with collared brawn, or pigs' heads as they are called with us, and for sausages and polonies. I understand, also, from those who have been in the habit of making them, that horseflesh materially assists the making of sausages; it is a hard fibrine, and it mixes better and keeps them hard, and they last longer in the shop-window before they are sold, because otherwise the sausages run to water and become soft and pulpy. I believe horseflesh also materially assists German sausages; it keeps them hard."

To the above account we may add that German sausages and polonies are very generally coloured with large quantities of *Venetian red* or *reddle.*

Having now gone over the chief articles used at the *Breakfast Table*, we shall in the next place proceed to describe the adulterations of those consumed more particularly, though not exclusively, at the *Dinner Table.*

Potted and all other meats are free of duty.

MUSTARD, AND ITS ADULTERATIONS.

The plants from which mustard is obtained are, *Sinapis nigra*, or black, and *Sinapis alba*, or white mustard ; they belong to the natural family *Cruciferæ.*

The black mustard plant is distinguished by its seed vessels, which are smooth, and the colour of the seeds themselves, which are reddish, or blackish brown.

In the white mustard plant the seed vessels or pods are clothed with hairs, which render them rough, and the seeds are yellow.

The two species of mustard differ in properties as well as in botanical characters.

The seeds of *S. nigra* are more pungent than those of *S. alba*, but there are other differences.

The young or seed leaves of white mustard are used for salad.

Both species are indigenous, and may commonly be seen in flower, in the month of June, in waste places and fields. In the brick fields in the neighbourhood of Notting Hill, they grow in great quantities.

The subjoined particulars, in reference to the manufacture of mustard, as furnished by a manufacturer, are given by Pereira :—

"The seeds of both black and white mustard are first crushed between rollers, and then pounded in mortars. The pounded seeds are then sifted. The residue in the sieve is called *dressings*, or *siftings ;* what passes through is *impure flour of mustard.* The latter, by a second sifting, yields *pure flour of mustard*, and a second quantity of dressings. By pressure the dressings yield a fixed oil, which is used for mixing with rape and other oils."

Composition of Mustard.

Analysis has detected in *black mustard seed* several distinct chemical compounds — *Myronic acid*, *Myrocyne*, *a volatile oil*, and *a fixed oil of mustard.*

Myronic acid is an inodorus, non-volatile, bitter, and non-crystallisable substance, containing nitrogen and sulphur, and forming salts with bases. The characteristic property of this substance is, that it yields, with myrocyne, the volatile oil of mustard.

Myrocyne, the *emulsin* of black mustard, yields, as already noticed, with myronic acid, the volatile oil of mustard. "It has considerable resemblance to vegetable albumen and emulsin, but as it cannot be replaced by either of these substances in the development of the volatile oil, it must be regarded as a substance *sui generis.* It is soluble in water ; but is coagulated by heat, alcohol, and acids, and in this state it loses the power of acting on the myronates, and of yielding the volatile oil."—*Pereira.*

The *volatile oil of mustard* does not pre-exist in black mustard seeds, but is formed, as already observed, by the mutual action of myronic acid and myrocyne in cold or warm water; it is this oil which gives to mustard its penetrating odour, sharp burning taste, and its acrid, rubefacient, and vesicant properties: it contains nitrogen and sulphur in its composition.

The above details are of practical interest and importance, for since heat coagulates myrocyne, and this substance is necessary to the formation of the volatile oil upon which the greater part of the active properties of mustard depends, it is clear that water either cold or warm only, should be employed in the mixing of mustard.

The *fixed oil of mustard* is usually procured from the siftings or dressings of mustard, which consist mainly of husk: it is stated to constitute about twenty-eight per cent. of the seeds.

Of the composition of *white mustard seed* we find the following account in Pereira's "Materia Medica:"—

"Robiquet and Boutron (*Journ. de Pharm.*, xvii. p. 279.), however, have proved, that white mustard contains neither volatile oil, nor any substance capable of producing it, but owes its activity to a *non-volatile acrid substance*, which does not pre-exist in the seeds, but is readily formed in them under certain conditions. Another chemical peculiarity of white mustard is, that it contains *sulpho-sinapisin.* (Henry and Garrot, *Journ. de Chim. Méd.*, i. 441.) Hence, while sesquichloride of iron strikes a deep red colour in an infusion of white mustard, it merely communicates an orange tint to the infusion of black mustard. Moreover, the thick mucilaginous liquor obtained by digesting the seeds of white mustard in cold water is peculiar to them. (Cadet, *Journ. de Pharm.*, xiii. 191.) Simon (*Journ. de Pharm.*, xxv. 370.) has announced the existence of a new principle, which he calls *erucin.*"

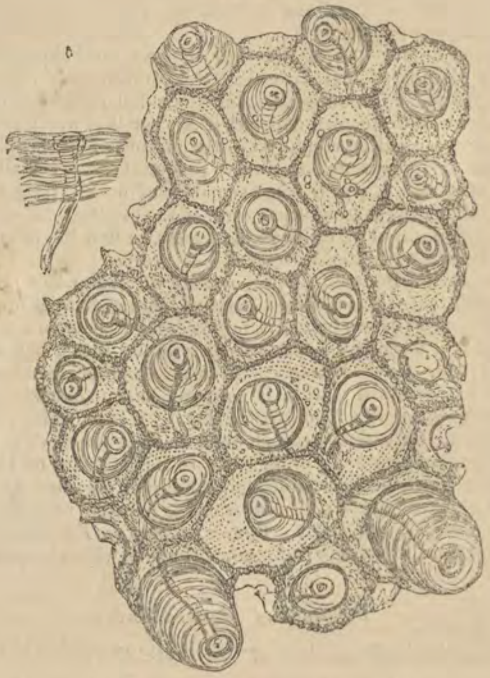
Structure of Mustard Seed.

Every entire seed consists of two parts, the husk and the seed proper.

The husk of *white mustard seed* is constituted of three distinct membranes.

The *outer* membrane is transparent, and mucilaginous; it consists of a layer formed apparently of two different kinds of cells of large size and very peculiar structure; those of the first kind are of an hexagonal figure, and united by their edges so as to form a distinct membrane, the centre of each cell being perforated; the cells of the second kind occupy the apertures which exist in the previously described cells, and they are themselves traversed by a somewhat funnel-shaped tube, which appears to terminate on the surface of the seed: immersed in water, these cells swell up to several times their original volume, occasion the rupture of the hexagonal cells, and become themselves much wrinkled or corrugated, the extremity of the tubes in some cases being seen protruding from the proximate termination of the cells. It is possible, however, that what are here described as two different kinds of cells really form distinct parts of the same cells.

Fig. 122.



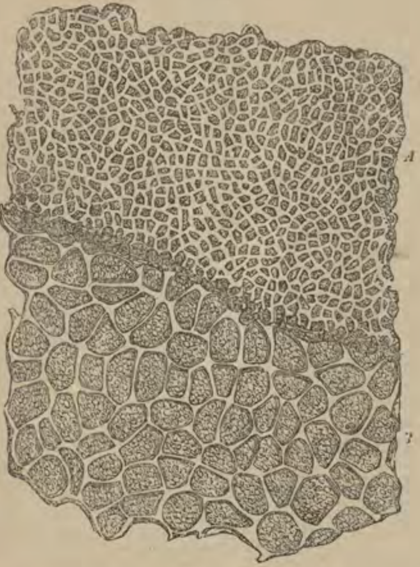
Fragment of the *outer* membrane of the seed of White Mustard.
Magnified 220 diameters.

It has been noticed that when white mustard seeds are digested in water, a thick mucilaginous liquid is obtained: the source of the mucilage does not appear to have been pointed out; it is certainly, however, derived from the cells forming the tissue above described.

The *middle* tunic consists of a single layer of very minute cells, of an angular form; it is in the cavities of these that the chief part of the colouring matter possessed by the husk is seated.

The *inner* membrane also consists of a single layer of angular cells, which, however, are several times larger than those constituting the middle tunic.

Fig. 123.



Fragments of the *middle* and *inner* tunics of *white* mustard seed, the former covering and lying upon a part of the latter. Magnified 220 diameters.
A. Portion of the *middle* tunic. *B*. A fragment of the *inner* tunic, showing the structure of that membrane.

The *seed* itself is of a bright yellow colour, and of a soft, waxy consistence, depending upon the quantity of oil it contains; it consists of innumerable very minute cells, in the cavities of which the oil and other active principles are contained. *Fig*. 124.

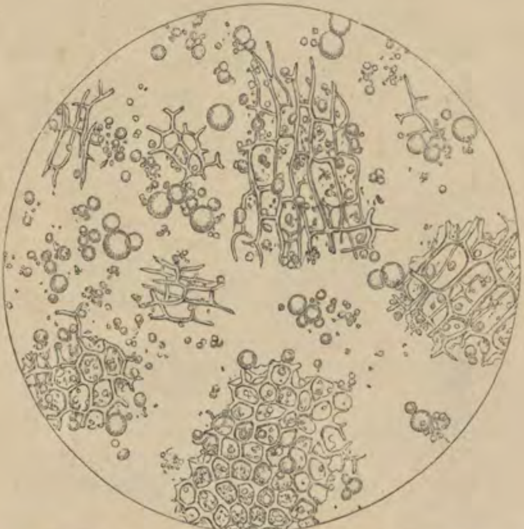
Notwithstanding the terms "flour" and "farina" of mustard commonly employed, ripe mustard seed does not contain a single starch granule, as may be ascertained by means of iodine and the microscope.

In *black mustard*, the outer membrane of the seed consists only of the large hexagonal transparent cells disposed in two or three layers, and not perforated in the centre like those of white mustard; the other structures resemble those of white mustard. *Fig*. 125.

ON THE ADULTERATIONS OF MUSTARD.

The ordinary adulterations of mustard are with *wheat flour* and *turmeric*, the employment of the first named article necessitating the use of the other to restore or bring up the colour to the original standard.

Fig. 124.



Sample of *genuine ground white mustard*. Drawn with the Camera Lucida, and magnified 220 diameters.

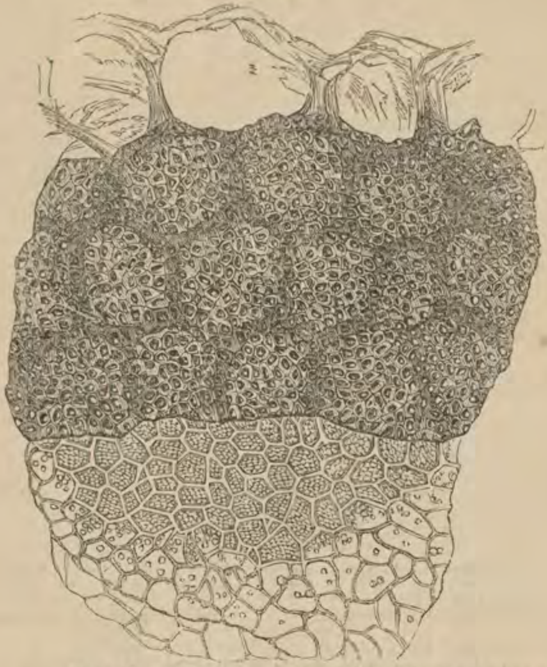
Results of the Examination of Samples.

No less than *Forty-two* samples of mustard purchased in the metropolis were subjected to examination :—the whole of them were found to consist of mixtures, in various proportions, of *wheat flour*, *turmeric*, and *mustard*.

Other adulterations sometimes practised are those with *Cayenne pepper*, *Sinapis Avensis*, or *charlock*, *clay*, *plaster of Paris*, and *chromate of lead*. The pepper is used to impart pungency to it when it has been otherwise adulterated; clay, for bulk and weight; and the chromate of lead, to restore the colour when reduced by other adulterations.

Mr. Warington states, in his evidence before the Parliamentary Committee on Adulteration, that some of the samples of mustard which he examined contained from 20 to 30 per cent. of inorganic matter, chiefly sulphate of lime; the genuine mustard when burned yielding from 4½ to 6½ per cent. of residue.

Fig. 125.



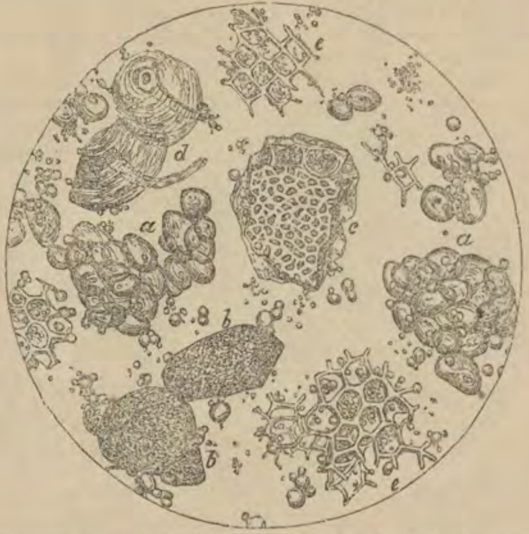
Husk of Black Mustard *seed*. Magnified 220 diameters.

Mr. Gay, formerly a mustard and chicory manufacturer, and now Superintendent of the Mustard Department in her Majesty's Victualling Yard at Deptford, furnished the Committee above named with, amongst other information, the following respecting the adulteration of mustard. He states,—

"I believe very few scruple to use wheaten flour, turmeric, and Cayenne pepper. The adulterants I used were flour, turmeric, Cayenne pepper, and *ginger*.

"But farina is also used, and *potato starch* is used to a very great extent; and now, I am sorry to say, what one of the witnesses called terra alba, or plaster of Paris. I have had some samples in my office in the mustard department since I have been in my present situation, from which I have extracted 5 ounces of gypsum in the pound; from another sample I got 5 ounces of *rice* and wheaten flour. I have seen more than 50 per cent. of gypsum in mustard."

Fig. 126.



This engraving represents the articles detected in a sample of "*double superfine* MUSTARD," marked with the names of Messrs. J. & J. Colman: *a a*, *wheaten flour*; *b b*, cells of *turmeric powder*; *c*, portion of *husk of black mustard*; *d*, cells of outer tunic of *white mustard seed*; *e e*, fragments of the *seed* itself.

With regard to the adulteration of mustard with charlock, Mr. Gay remarks, "When mustard seed is worth 20*s.* per bushel, and charlock about 6*s.* or 8*s.* a bushel, it is worth buying."

It is also alleged that *pea flour*, *radish* and *rape seed*, *linseed meal*, and *yellow ochre* have been employed in the adulteration of mustard.

No less than four different qualities of mustard are supplied by the mustard manufacturer, under the name of "Seconds," "Fine," "Superfine," and "Double Superfine;" the chief difference between these articles is, that the lower the quality the larger the proportion of wheat flour and turmeric which they contain.

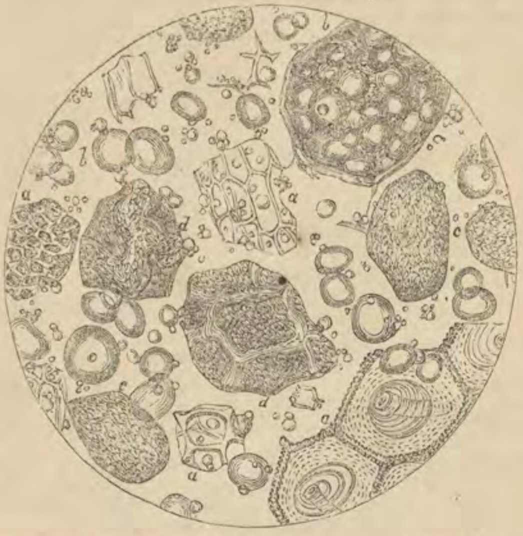
These several qualities may be purchased at about the following rates: seconds, 5*d.*; fine, 8*d.*; superfine, 11*d.*; and double superfine, at 1*s.* 2*d.* per lb.

The practice of making so many different qualities of mustard is open to much objection, since it gives the unscrupulous dealer the greatest scope for imposition. The poor man buys his mustard by the ounce, and for this he usually pays 1*d*., receiving in return seconds, fine, or superfine mustard, according to the conscience of the vendor.

It can now be understood how it happens that some of the mixtures which we buy for mustard scarcely possess the flavour of that article, and how, when used for poultices, they produce little or no effect, a matter oftentimes of vital consequence.

Doubtless we shall be told by the mustard manufacturer, that genuine mustard is a very unpalatable thing, that it is bitter to the taste, and not pleasant to look at; but the answer to this is, that the article mustard is not always made according to one receipt, and that there exist, even in England, a few manufacturers who make and sell only genuine mustard.

Fig. 127.



MUSTARD, *a a*; adulterated with *b b*, *wheat flour*; *c c*, *turmeric*; and *d d*, *Cayenne*. Magnified 225 diameters.

On the Detection of the Adulterations of Mustard.

The detection of the ordinary adulterations of mustard is effected very readily by means of the microscope. The characters of *wheat flour* are described and figured at p. 243., and of *turmeric* under the head of that article.

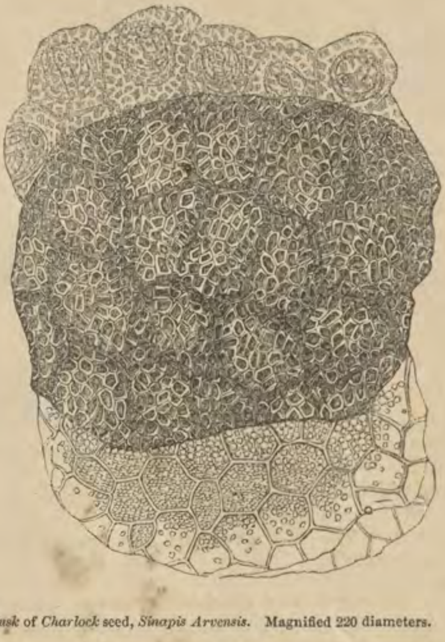
The adulterations by the other vegetable substances referred to are also discoverable with the microscope. Descriptions and figures of *pod pepper* will be found under the head of Cayenne, and of *linseed meal* under that of Pepper.

The presence of turmeric is also discovered by adding strong ammonia to a small quantity of the mustard, causing it to become of an orange red colour if that substance is present. This is a very simple and efficient test. The characters of mustard, adulterated with wheat flour, turmeric, and Cayenne, are exhibited in *Figs.* 126. and 127.

On one occasion we succeeded in detecting by the microscope *turmeric* in a sample of mustard when added in the minute proportion of two ounces to fifty-six pounds of seed, or one part of turmeric to 448 parts of mustard.

As there is good reason to believe that the seeds of *charlock* and of *rape* are sometimes employed in the adulteration of mustard, we now append figures and descriptions of the husks of those seeds.

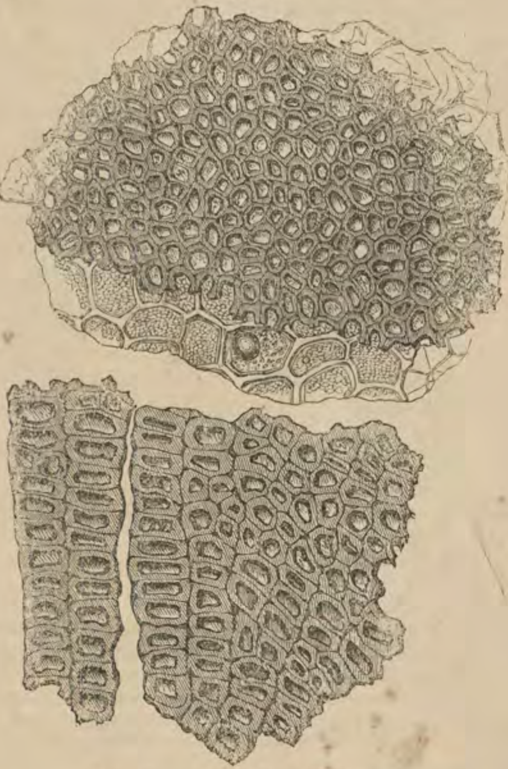
Fig. 128.



Husk of *Charlock* seed, *Sinapis Arvensis*. Magnified 220 diameters.

Structure of Sinapis arvensis, or Charlock.—The husk of this seed resembles, in colour, very closely black mustard, from which, however, on a careful examination, it may be discriminated by means of the microscope, notwithstanding the statement of Mr. Gay, made before the Parliamentary Committee, "that no analytical chemist could detect charlock seed mixed with mustard, even with the microscope."

Fig. 129.

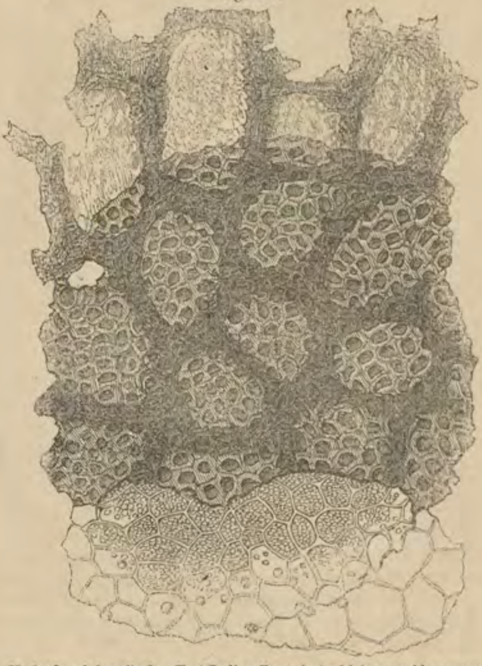


Husk of RAPE *Seed.* Magnified 220 diameters.

While it agrees in colour with the husk of black mustard, it approaches in structure nearer that of white mustard, from which, however, it may be distinguished in the most satisfactory manner. The chief difference is in the cells of the outer or mucilaginous coat; these are smaller and more delicate than those of the husk of white mustard: they are perforated like them, however, but in addition they each seem to be made up of numerous angular very delicate and minute cells; these are very characteristic of the seeds of charlock. *Fig.* 128.

Structure of Rape Seed.—The membranes forming the husk of rape seed are so distinct that no difficulty need be experienced in distinguishing this seed from those of any of the mustards. It is composed of two membranes, the outer resembling somewhat the second membrane of the husk of the mustards, but the cells are much larger, and in consequence their cavities do not appear black in general, but more or less light, the walls of the cells being thick and well defined; near the umbilicus of the seed the cells usually are disposed in a linear

Fig. 130.

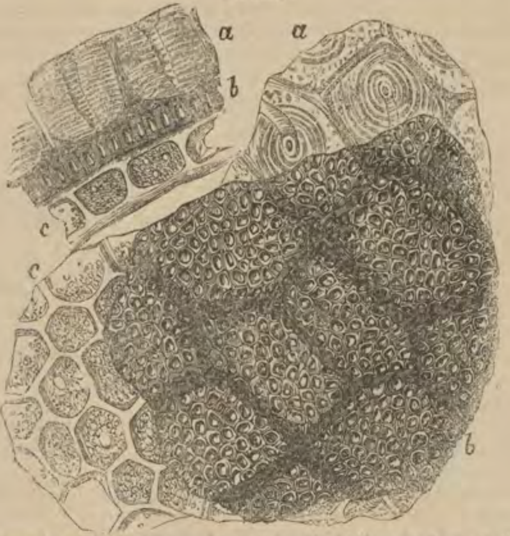


Husk of seed described as East Indian Rape, but which resembles a species of *Mustard.* Magnified 220 diameters.

manner. The innermost membrane does not present any peculiarity.

In a sample of rape cake forwarded to us for examination, and suspected to be adulterated with mustard, we met with what appeared to be the husk of a species of mustard. It is represented in *fig*. 131,

Fig. 131.



Transverse and *Vertical Sections* of husk of a species of MUSTARD SEED met with in a sample of adulterated rape, and from the consumption of which some cattle are said to have died.

It approaches in structure most nearly to the husk of black mustard, but the cells of the first coat are perforated, and those of both the first and second coats are much larger: in the large size of the cells of the second coat it comes somewhat near to the husk of rape seed: but then in this we have never met with any outer coat of large colourless cells. The husk in question, therefore, belongs most probably to some foreign species of mustard.

Radish seed, on account of its price, is scarcely likely to be employed in the adulteration of mustard; it is not necessary, therefore, to give a description of its structure.

For the discovery of the *inorganic adulterations* of mustard, recourse must be had to chemistry.

The process for the detection of *alumina* or *clay* is given at page 180., of *gypsum* or *sulphate of lime* at p. 99., of *yellow ochre* in the article on

Turmeric, and of *chrome yellow* or *chromate* of *lead* in that on Coloured Sugar Confectionery.

Mustard flour, duty 1*s.* 6*d.* per cwt. Ditto, mixed or manufactured (except flour), 5*s.* per cwt.

Imports of flour in 1854 and 1855, 3 and 2 cwts. respectively. Mixed or manufactured, other than flour, in 1854, 97 cwts., and in 1855, 106 cwts. Retained for home consumption, 95 and 78 cwts. in each of the years specified.

PEPPER, AND ITS ADULTERATIONS.

The natural family *Piperaceæ* includes four plants of great utility to mankind; two of these, *Piper nigrum*, or black pepper, and *Piper longum*, more recently named *Chavica Roxburghii*, or long pepper, are chiefly employed for dietetic and culinary purposes; whilst the others, *Piper Cubeba*, now *Cubeba officinalis*, and *Artanthe elongata*, or the matico plant, are principally employed in medicine.

The plant which yields Cayenne, *Capsicum annuum*, often improperly termed Cayenne pepper, does not belong to the family of *Piperaceæ* at all, but to that of *Solanaceæ*.

The pepper of commerce is furnished by Piper nigrum, and it is to this species, therefore, that on the present occasion we shall have to direct attention.

The black pepper plant grows both in the East and West Indies, in Sumatra, Java, and other islands; it is a shrubby, climbing plant, which attains the height of from eight to twelve feet. The berries, or peppercorns, grow on terminal flowerstalks or spadices; they are at first green, but change subsequently to red and then to black. When any of the berries on a spadix have begun to turn red, the whole are gathered, dried in the sun, and the stalks separated by the hand. In drying, the succulent part of each berry becomes contracted and wrinkled, forming a hardened wrinkled cortex; the corrugations being much raised, and describing a kind of elevated network.

The following more detailed particulars concerning the growth of the pepper plant and the gathering of the berries are extracted from M'Culloch's "Dictionary of Commerce": —

"It climbs to the height of twenty feet, but is said to bear best when restrained to the height of twelve feet. It begins to produce at about the third year, and is in perfection at the seventh; continues in this state for three or four years, and declines for about as many more, until it ceases to be worth keeping. The fruit grows abundantly from all its branches, in long, small clusters of from twenty to fifty grains; when ripe it is of a bright red colour. After being gathered, it is spread on mats in the sun, when it loses its red colour, and becomes black and shrivelled as we see it. The grains are separated from the stalks by hand-rubbing. That which has been gathered at the proper period shrivels the least; but if plucked too soon, it will become broken and dusty in its removal from place to place. The vine produces two crops in the year, but the seasons are subject to great irregularities."

Those berries are the best which are not too small nor too much corrugated; which are heavy, and sink readily in water.

The two varieties of pepper known as "black" and "white" pepper are both obtained from the same plant: black ground pepper is the entire berry reduced to powder, while the white consists of the same berry decorticated or deprived of its outer and black husk or covering.

We learn from Pereira that three kinds of *black pepper* are distinguished by wholesale dealers. These are: —

"*Malabar pepper.* — This is the most valuable; it is *brownish-black*, free from stalks, and nearly free from dust."

"*Penang pepper.* — This is *brownish-black*, larger, smoother, free from stalks, but very dusty. It is sometimes used in England to manufacture white pepper."

"*Sumatra pepper.* — This is the cheapest sort; it is *black*, mixed with stalks, and contains much dust. Under the name of Sumatra pepper, some dealers include the Penang or brownish-black sort, and the black Sumatra sort."

Three kinds or varieties of *white pepper* have also been distinguished.

"*Tellicherry pepper*, which is of two kinds: large or fine Tellicherry pepper is larger and whiter than any other description of white pepper, and fetches a higher price; small or coriander-like pepper is shrivelled."

"*Common white pepper* comes from Penang by Singapore; it is round, and not shrivelled; its value depends on its size and whiteness."

"*English bleached, or white pepper.* — When the two preceding sorts are scarce, brown Penang pepper is bleached. The yellowest and largest grains are chosen for this purpose, for neither an expensive nor small sort would pay."

On the Composition of Pepper.

The active properties of pepper depend upon the presence of *an acrid resin*, *a volatile oil*, and a crystallisable substance called *Piperine*.

The following is the composition of *black* and *white* pepper, according to Pelletier * and Lucä †: —

---

* Ann. de Chim. et de Phys. xv. 344.

† Schwartze, Pharm. Tabella.

Black Pepper (Pelletier).

Acrid soft resin.
Volatile oil.
Piperine.
Extractive.
Gum.
Bassorin.
Starch.
Malic acid.
Tartaric acid.
Potash, calcareous, and magnesia.
Salts.
Woody fibre.

White Pepper (Lucä).

Acrid resin - - -	16·60
Volatile oil - - -	1·61
Extractive, gum, and salts	12·50
Starch - - -	18·50
Albumen - - -	2·50
Woody fibre - -	29·00
Water and loss - -	19·29
	100·00

In Lucä's analysis the piperine is probably included in the resin.

The *resin* is very acrid, soluble in alcohol and ether, but not in volatile oil.

The *volatile oil* has the odour and taste of pepper. Its specific gravity is 0·9932.

Piperine is a crystallisable substance; the crystals being rhombic prisms with inclined bases: it fuses at 212° F., is insoluble in cold water, and only slightly so in boiling water; it dissolves in alcohol, from which piperine is thrown down when water is added; ether and acetic acid also dissolve it, but the first is not so good a solvent as alcohol. It is tasteless and inodorous: with strong sulphuric acid it forms a blood-red liquid; nitric and hydrochloric acids turn it first greenish-yellow, then orange, and afterwards red.

Structure of Pepper.

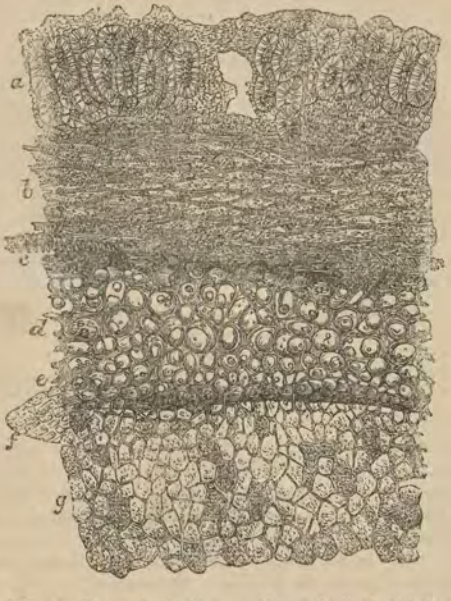
Structure of the Berry.—The berry of the black pepper plant possesses a structure of considerable complication, and of much interest; and since without an accurate knowledge of its minute organisation we cannot hope to be in a position to detect the numerous adulterations to which this article is subject, it becomes necessary to describe somewhat minutely the tissues which enter into its formation.

In a section of the berry, two parts are to be distinguished — an outer and an inner: the first is black, or reddish-black; and the second more or less white, hard, and brittle, except in the centre of the seed, where it is frequently soft and pulverulent.

When a thin vertical section of the outer or cortical part of the berry is examined, by means of the microscope, it is seen to be composed of several distinct parts, each of which is constituted of one or more layers of cells. Such a section is represented in *fig.* 132.

The external part of the berry, marked *a* in the following figure, is constituted of cells of an elongated form, placed vertically. These cells are provided with a central cavity from which lines, probably minute canals or channels, radiate towards the circumference; when viewed sideways, they appear rather more than twice as long as broad; and when seen endways, they appear mostly oval in shape, and but little longer than broad. Cells of a somewhat similar character are described in the Report on Sugar, as entering into the formation of the epidermis of the sugar cane.

Fig. 132.



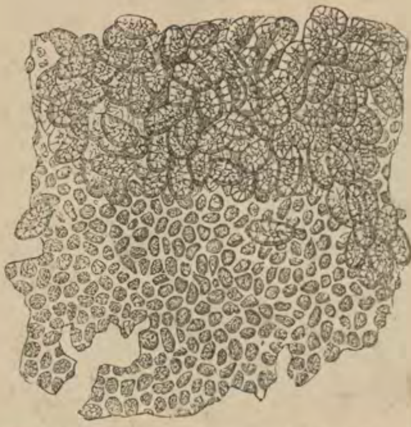
Section of a **Pepper Berry**, showing the several layers of cells of which the *cortical part* is constituted, and the junction of this at *f* with the central portion, *g*. Drawn with the Camera Lucida, and magnified 80 diameters.

The cells next in order, and upon which the previously described cells rest, are small, angular, and dark coloured; they, as well as the radiate cells, are shown in *fig*. 133.

The small angular cells, just noticed, do not appear to separate readily from the cells which occur immediately beneath them, and of which they are probably mere modifications; strictly speaking, therefore, they ought to be considered as forming part of the layer next to be described, and we have spoken of them separately only for convenience of reference and description.

The cells now to be described are two or three times larger than those previously noticed, and very numerous, forming about half the thickness of the cortex; they are all more or less coloured, and the colour deepens as the cells approach the next layer. The position of this second layer is pointed out at *b*, *fig*. 132. The third layer is very thin, and is composed of woody fibre, bundles of spiral vessels of small size, and formed of single threads, *fig*. 132. *c*.

Fig. 133.



A portion of the *cortex* of the PEPPER BERRY, viewed on the surface, showing the cells which form its first and second layers. Drawn with the Camera Lucida, and magnified 120 diameters.

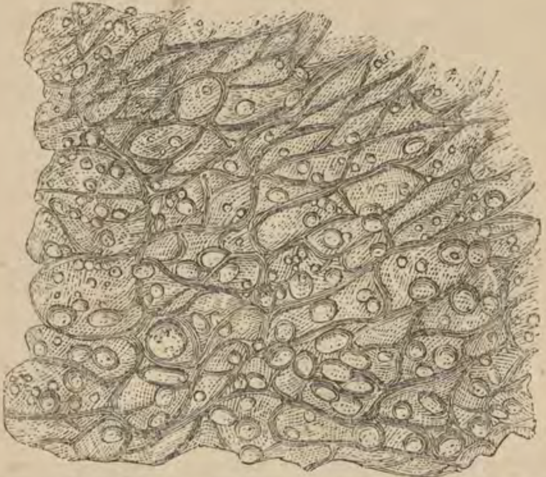
The junction of the second with the third layer is pointed out by a dark line situated about the middle of the cortex; see *fig*. 132. *c*.

The fourth layer is composed of numerous large cells, and it constitutes the greater part of the remaining half of the cortex (*fig*. 132. *d*). As the cells approach the central part of the berry, they become much modified, two or three times smaller, and of a deep red colour (*fig*. 132. *e*); these cells might be described as forming a fifth and distinct layer.

The numerous cells which form the fourth layer contain a very great abundance of oil globules, and it is in it that the essential oil of the pepper berry is chiefly located.

The cells which form the fifth and last tissue which enters into the composition of the cortex of the pepper berry are divisible into two or three layers, the outer are coloured, and the inner invariably colourless; the colourless cells present a reticulated appearance, forming a transparent lamina which frequently separates, as a distinct tissue. *Fig*. 132. *f*.

Fig. 134.



A portion of the *fourth lamina* of the cortex of PEPPER BERRY, showing the oil contained in the cavities of the cells. Drawn with the Camera Lucida, and magnified 120 diameters.

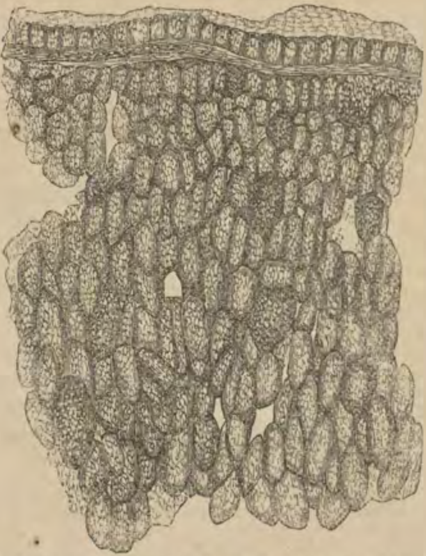
The *central part* of the berry or seed is constituted of cells of large size and angular shape; they are about twice as long as broad, and disposed in a radiate manner; in the outer part of the seed they are adherent, hard, and stonelike, while in the centre they are readily separable, and often form a powder resembling flour. *Fig*. 132. *g*, *and Fig*. 135.

When the pepper berry is macerated in water for some hours, the cortical part apparently separates without difficulty from the seed proper; if, however, we examine the surface of this closely, we observe that it is of a reddish colour, and it becomes evident that a portion of the cortex is still adherent, this consisting of part of the fourth layer, containing much of the oil, and the fifth layer.

It now becomes apparent that the terms in common use, "white pepper," and "decorticated pepper," are not altogether correct, for the berry is not entirely denuded of the cortex, nor is its powder white, for if a little of it be diffused through water on a slip of glass, reddish particles immediately become visible: these are fragments of that portion of the cortex which remains firmly adherent to the seed itself.

When sections of the inner part of the pepper berry are immersed in water for a short time, they assume a yellowish or canary tint, and when examined with the microscope, the colour is seen to be confined

Fig 135.



Section of the *central portion* of the PEPPER BERRY, showing the two kinds of cells of which it is composed, the colourless and coloured cells, and also its junction with the cortex. Drawn with the Camera Lucida, and magnified 120 diameters.

to certain of the cells only, of which the sections are composed; these cells are rather larger than the ordinary cells; they are placed at tolerably regular distances from each other, and they reflect a deep yellow colour. In recent sections which have not been immersed in water, the cells, which afterwards become yellow, may be distinguished by a darker shading, and sometimes by a faint tint of colour. The deepening of colour is determined by the action of the salts contained in water on the contents of these cells, which differ chemically from those of the ordinary cells.

It is probably in these coloured cells that the piperine is located. Alcohol and nitric acid deepen the tint very gretaly, and on the application of concentrated sulphuric acid to dry sections of the pepper berry, they become of a reddish hue, the change of colour being limited, in the first instance, to the peculiar cells in question. These results of the use of sulphuric acid are such as ensue with piperine itself.

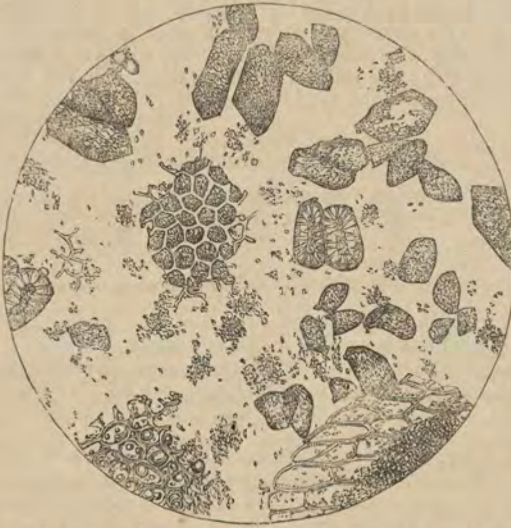
The structure of the central part of the pepper berry, and the position and character of the coloured cells, are shown in *fig*. 135.

Now, in ground black pepper, all the structures which we have described may be traced out in a broken and fragmentary condition, but in white pepper certain of these tissues only exist—viz., a part of the fourth layer of cells, which contains the oil, and the fifth cellular lamina.

Before the observer is in a position to detect the adulterations of pepper, it is necessary that he should well understand the appearances and structure of ground pepper, both black and white.

When black pepper is diffused through water, little particles of three different kinds, intermixed with a fine powdery substance, are visible; some of these are black, others reddish, and the last white; the black are fragments of the outer, and the red those of the inner cortex, while the white are the pulverised seed itself. The white powder is formed of the cells of the seed, some united in twos and threes, but the majority either separated and entire, or broken into pieces; these cells contain starch granules of extreme minuteness. The engraving (*fig*. 136.) will serve to convey a good idea of the appearances

Fig. 136.



Ground and unadulterated BLACK PEPPER. Drawn with the Camera Lucida, and magnified 120 diameters.

presented under the microscope by ground and unadulterated black pepper.

In the black particles but little evidence of structure is in general to be seen, and where doubt is entertained of their nature, it is necessary that they should first be bleached with chlorine, torn into pieces with needles, and then examined with the microscope.

In genuine white pepper no black fragments ought to be seen, but numerous reddish-brown particles are always present, usually adherent to the white cells which form the central part of the berry.

These white cells, when separated from each other, whether entire or broken, being of angular form, very hard, and reflecting deep shadows, bear a strong resemblance to particles of sand, for which they would be very apt to be mistaken by persons unacquainted with the microscopic structure of the pepper berry.

The cavities of these cells are filled with starch granules of exceeding minuteness, and, as in ground pepper, many of the cells are broken into pieces, some of the granules become effused; these are so very small that they are generally in a state of molecular movement, and they resemble spherules of oil rather than starch granules. No other starch grains exist in the berry besides those just described.

So great is the quantity of starch contained in the seed or central part of the berry, that the cells when touched with a solution of iodine become deep blue; the yellow cells being affected in the same manner, but more tardily and to a less extent.

ON THE ADULTERATIONS OF PEPPER.

Pepper is subject to very great and scandalous adulterations, and this although it is one of the few articles placed under the supervision of the Excise.

Results of the Examination of Samples.

Out of *Forty-three* samples of black and white pepper examined in 1851, we found *nearly one half to be adulterated.*

The substances detected were *linseed meal*, *mustard husk*, *wheat flour*, *pea flour*, *sago*, *rice flour*, and *pepper-dust.* To this list must now be added *woody fibre* recently met with by the Excise in samples of pepper.

Pepper dust, H.P.D or P.D, consists either of the sweepings of the warehouses, or else of an article made up in imitation of ground pepper, and expressly used for the adulteration of that article.

Mr. George Phillips, of the Excise, gave the following evidence, before the Committee on Adulteration, respecting the adulteration of pepper: —

The number of samples examined in nearly twelve years was 1116, of which 576 were found to be adulterated. "We have found rice, sago, potato starch, linseed meal, Chilis, husks of red and white mustard, wheat, bran and flour, and ground gypsum or crystallised sulphate of lime. The stock material for adulterating pepper is the husks of red and white mustard seeds and linseed meal, warmed up with Chilis."

Of 100 lbs. of an article seized in 1852 at Chelmsford as pepper, 2 lbs. only consisted of pepper, the rest being husks of mustard, Chilis, and rice. *Rape seed* has also been found in pepper. Mr. Gay, from whose evidence we have before quoted, states that white pepper is sometimes adulterated with *bone dust*, commonly called *ivory dust*. He also gave the following receipt for P.D.: — "It is manufactured from rape or linseed cake, mustard husks, and Cayenne pepper."

Some years since it was not uncommon to meet with *artificial peppercorns;* instances of their occurrence are mentioned in Thomson's "Annals of Chemistry," and also by Accum, in the second edition of his celebrated work — "Death in the Pot."

Accum writes: "I have examined large packages of both black and white pepper by order of the Excise, and have found them to contain about 16 per cent of this artificial compound. This spurious pepper is made of oil cake, the residue of the linseed from which the oil has been pressed, common clay, and a portion of Cayenne pepper, formed into a mass, and granulated by being first pressed through a sieve, and then rolled in a cask."

The case of pepper affords a lamentable instance of the inefficiency of the Excise in checking adulteration.

On the Detection of the Adulterations of Pepper.

The whole of the adulterations of pepper mentioned, except that with the husk of pepper, are only to be detected in a certain and satisfactory manner by means of the microscope.

The characters of the starch granules of wheat, rice, and potato, have already been described; those of wheat at p. 243., those of rice at p. 255., of potato flour at p. 320., and of sago at p. 325.

The structure of *mustard* and *rape seed*, and of *Cayenne*, will be found described and figured under the heads of Mustard and Cayenne; the method of detecting *sulphate of lime* is given at p. 99.

It then only remains for us to describe the structure and appearances of *linseed meal* and of *pea flour.*

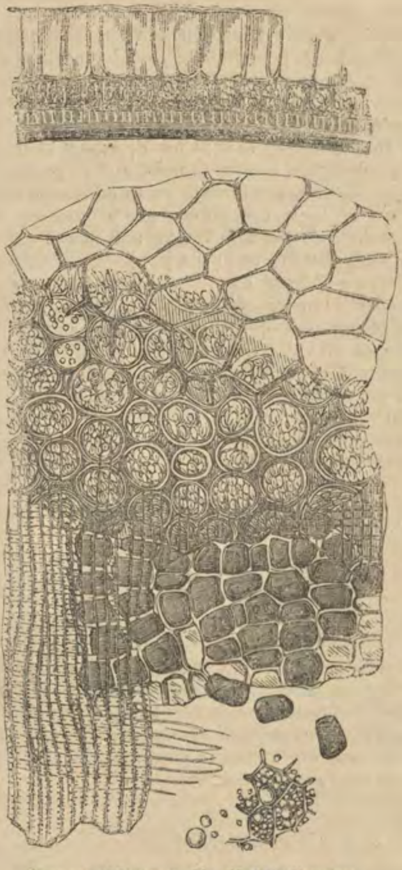
Structure of Linseed Meal.

Linseed possesses a very beautiful structure; four coats or tunics enter into the composition of the covering of the seed, and require description.

The *outer* coat gives the polish to the seed, and is composed of a single layer of large and colourless cells, of an hexagonal form.

It is in the cells which form this tunic that the mucilage which linseed yields so abundantly, on infusion, is contained.

Fig. 137.



Structure of LINSEED. Magnified 220 diameters.

The *second* coat consists of a single layer of cells enclosing granular matter; they are of a rounded form, and have thick walls.

The *third* membrane is composed of narrow elongated cells, or rather fibres, some being longitudinal and others transverse; these give it a striated and very characteristic appearance; being firm and strong, it forms the protecting tunic of the *seed.*

The *fourth* membrane is made up of angular cells, many of which are more or less square, enclosing masses of colouring matter, probably of a resinous character, and which readily fall out of the cells, as represented in the figure.

The *substance of the seed* consists of cells, in the cavities or meshes formed by which the oil and starch granules are enclosed.

The *oil* is contained principally in the outer or more superficial cells, in the form of brilliant and pearl-like minute drops or spherules.

The *starch granules* are most abundant in the interior of the grain; they are angular, minute, and two or three times larger than those of the peppercorn.

The whole of the structures above described may be satisfactorily detected, by a little patient investigation, in the linseed reduced to powder or meal. The parts, however, most frequently and clearly seen, are fragments of the fibrous coat, and little masses of the seed, from the edges of which, portions of the cellulose forming the transparent cells project, in a radiate and very characteristic manner.

Structure of Pea Flour.—Pea flour resembles very closely bean flour already described and figured under the article Bread, the chief difference consists in the size of the starch corpuscles, which are much smaller in pea than in bean flour.

On the Detection of Pepper Husks.—The presence of an undue quantity of pepper husk in black pepper may be suspected by the appearance of the article, its dark colour, and the quantity of husk visible to the naked eye; the only way, however, in which this admixture is to be determined with certainty, is by a quantitative chemical analysis of the sample.

It is not often that such an analysis is necessary.

On the Detection of Factitious Pepper Berries.—The suspected pepper should be soaked for some time in water, when, should it contain artificial peppercorns, these will become disintegrated and fall to pieces. Their composition is to be ascertained partly by chemical analysis and partly by microscopical examination.

The processes for the detection of *sulphate of lime* and *bone dust* have already been described elsewhere.

Duty on pepper, of all sorts, is 6*d.* per lb., and 5 per cent. thereon. There were entered for home consumption in 1854, 3,720,534 lbs.; 1855, 3,647,803 lbs.; nine months of 1856, 2,646,910 lbs. It is evident therefore that the loss to the revenue arising out of the adulteration of this single article must be very great.

CAYENNE, AND ITS ADULTERATIONS.

Cayenne Pepper consists of the pods or seed vessels, ground and reduced to powder, of different species of *Capsicum*, but principally of *C. annuum*, and *C. frutescens;* the latter species, being stronger and better flavoured, yields the best description of Cayenne pepper.

The genus capsicum belongs to the *Solanaceæ* or nightshade family, which also includes the potato plant.

Capsicum annuum is a native of America, but is cultivated in the West and East Indies, and to some extent, in greenhouses, in England and other European countries.

It is an annual, herbaceous plant, and, according to M'Culloch, "one of the hardiest and most productive plants found in tropical climates, growing luxuriantly in almost all dry soils, however indifferent." In this country it flowers in July, and ripens its pods in October; when immature, the berries are green, and only gradually become red as they grow ripe; they are used both in the green and red states, and in the undried and dried conditions: in the recent state they are employed for pickling; when dried they are used in medicine; and, reduced to powder, they constitute Cayenne pepper.

The dried berries ordinarily sold as *chillies* are of this species; in this condition they are more or less shrivelled, oblong, broad at the distal extremity, the calyx and stalk being usually adherent to the broad end. They vary very much in size and form; the largest are two or three inches long, and at the base are an inch or more wide; they are distinguished, according to their size and shape, into long-podded, short-podded, and heart-shaped.

The pods of this capsicum are hot and pungent, but they have *no aroma.*

The pods of *Capsicum frutescens* constitute what is known as *guinea* or *bird pepper*, and when ground they furnish the best description of Cayenne pepper. They are small, scarcely an inch in length, a line or two broad, and of a deep orange-red colour. Each berry encloses usually about a dozen flattened, reniform seeds.

The pods are hotter and more fiery than those of *C. annuum;* they are likewise to some extent *aromatic.*

Two other species of Capsicum have been denominated, from the form of the fruit, *Cherry chilly* or *Cherry pepper — Capsicum cerasiforme*, and *Bell pepper* or *Capsicum grossum.*

Composition of Cayenne.

The composition of capsicum berries is shown in the following analyses made in the years 1816 and 1817:—

Bucholz's Analysis.[*]

(1816.)

Acrid soft resin (*capsicin*)	4·0
Wax	7·6
Bitter aromatic extractive	8·6
Extractive with some gum	21·0
Gum	9·2
Albuminous matter	3·2
Woody fibre	28·0
Water	12·0
Loss	6·4
Fruit of *Capsicum annuum*, without seeds	100·0

Braconnot's Analysis.[†]

(1817.)

Acrid oil	1·9
Wax with red colouring matter	0·9
Brownish starchy matter	9·0
Peculiar gum	6·0
Animalised matter	5·0
Woody fibre	67·8
Salts: citrate of potash 6·0 Phosphate of potash, and Chloride of potassium 3·4	9·4
Fruit of *Capsicum annuum*	100·0

Of *capsicin*, the active principle of Cayenne, Pereira gives the following account:—

"Obtained by digesting the alcoholic extract in ether, and evaporating the ethereal solution. It is a thick liquid, of a yellowish-red or reddish-brown colour, which becomes very fluid when heated, and at a higher temperature is dissipated in fumes. Half a grain of it volatilised in a large room causes all who inspire the air of the room to cough and sneeze. By exposure to air and light it solidifies; it is decolorised by chlorine; it is slightly soluble in water and in vinegar, but very much so in alcohol, ether, oil of turpentine, and the caustic alkalies; with baryta it forms a solid acrid combination."

Structure of the Capsicum Berry or Fruit.

Each capsicum berry is made up of three parts—an outer skin or epidermis, parenchyma, and seeds.

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[*] Gmelin, Handb. d. Chem. ii. 1310.

[†] Ann. de Chim. Phys. vi. 122.

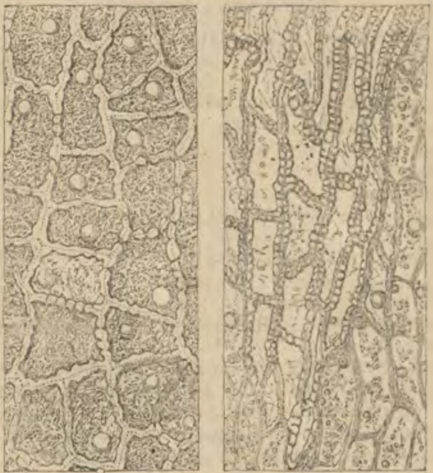
The *epidermis* consists of flattened cells, tortuous and angular in form. Viewed on the outer or upper surface, the borders of the cells are seen to be well defined; they are often four-sided; the walls are thick, beaded here and there, the beading of one cell corresponding to that of the contiguous cells; lastly, the lines of junction of the cells are sometimes faintly indicated.

Viewed on the inner surface the cells appear less angular, but more tortuous, the walls broader, and much more beaded. *Fig.* 138.

When fragments of the epidermis are seen immersed in water, numerous oil globules of a deep and beautiful orange-red colour are visible; some of these are imbedded in the cavities of the cells, but the majority float freely in the surrounding water.

These several structural particulars are well shown in the following engraving.

Fig. 138.

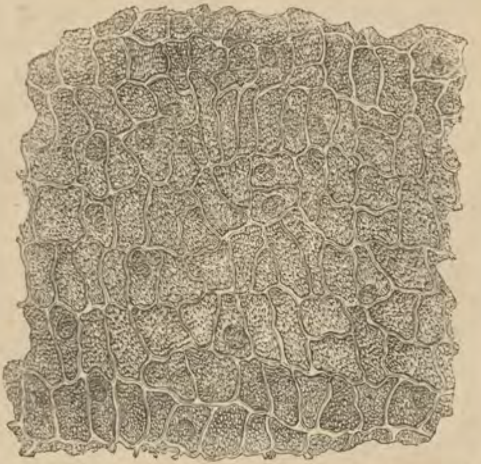


EPIDERMIS of CAPSICUM, outer and inner surfaces. Magnified 200 diameters.

In the next two figures the general appearance presented by the epidermis on a more superficial examination is exhibited, the minute details being omitted.

The *parenchyma*, which unites the seeds with each other, and the whole with the epidermis and peduncle, is likewise composed of cells; they are of a rounded or oval form, the parietes are thin, and their cavities usually contain a very large quantity of oil, in the form of innumerable droplets, many of considerable size, and which impart to this object, viewed under the microscope, a very beautiful appearance. *Fig.* 141.

Fig. 139.



A fragment of the *epidermis* of the capsicum berry, viewed on its outer surface.

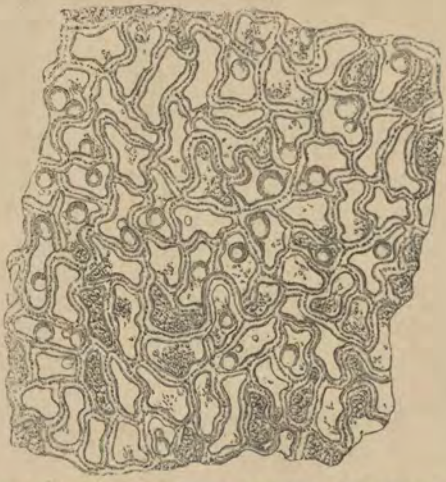
Fig. 142. represents a section of the cortical portion of the pod.

In the *seed*, two parts — the covering of the seed and the seed itself — require to be described.

The covering of the seed possesses a very peculiar structure, which it is difficult fully to understand, and therefore not easy to describe accurately. It is of a bright-yellow colour, and of considerable thickness. Viewed under the microscope, its outer surface presents a cellular texture, the margins of what appear to be the cells being thick and tortuous, and the cavities dark and depressed, as though they were rather apertures than the hollow interiors of the cells.

Vertical sections of this covering present a very singular appearance. In this view it appears as though composed of a number of tooth-like processes, having a somewhat radiate disposition, with intervals between each process, the points or summits of the teeth ending in very minute hook-like spines, the points of these being lost in a thin membrane forming the external covering of the seed. It appears that these tooth-like processes really consist of the thickened walls of contiguous cells (see *fig.* 143.); that this is really so is evident from an examination of the upper of the two sketches on the left of the section of the seed; they are best developed at the extremity of the seed.

Fig. 140.



A fragment of the *epidermis* of the capsicum berry viewed on its inner surface.

The seed proper consists of minute angular cells, having thick and colourless parietes; their cavities are filled with molecules and globules of oil of a yellowish or reddish-yellow colour, but do not contain starch.

ON THE ADULTERATIONS OF CAYENNE.

Cayenne is subjected to even more extensive adulteration than ordinary pepper.

Results of the Examination of Samples.

Of *Twenty-eight* samples of Cayenne submitted to microscopical and chemical examination, no less than *twenty-four were adulterated, and four only were genuine.*

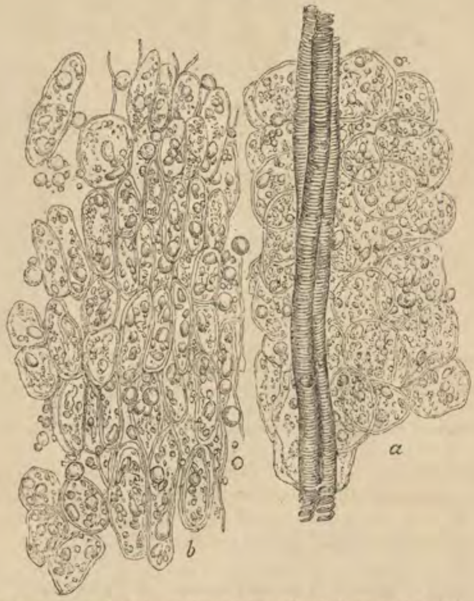
Twenty-two contained *mineral colouring matters.*

In *thirteen* cases this consisted of *red lead,* which was present in some of the samples in very considerable quantities, while in the remaining seven samples it was some red ferruginous earth, *Venetian red* or *red ochre.*

Vermilion, or *sulphuret of mercury*, was present in one of the Cayennes.

Six of the Cayennes consisted of a mixture of *ground rice*, *turmeric*, and *Cayenne*, coloured with either *red lead*, *Venetian red*, or *ochre*.

Fig. 141.



a, *parenchyma* of capsicum berry situated immediately beneath the epidermis; the cells in this situation are of a more rounded form, and are traversed by spiral vessels and woody fibre. *b*, the *parenchyma* surrounding the seeds.

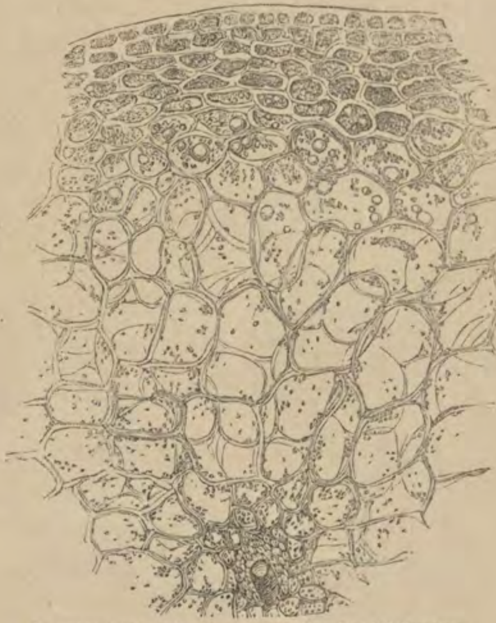
Six of the Cayennes contained large quantities of *salt*, sometimes alone, but mostly combined with *rice* and the *red earths* or *red lead.*

One of the samples was adulterated with a large quantity of the *husk of white mustard seed.*

Lastly, *two* were adulterated with *rice*, and were coloured in addition, the one with *red lead*, and the other with a *red ferruginous earth.*

The object of the use of red lead and other red colouring matters is twofold; first, to conceal other adulterations, and, second, to preserve the colour of the Cayenne, as, when exposed to the light for any time, it usually loses part of the bright-red colour which it at first possesses, and therefore it becomes deteriorated in the eyes of the purchaser. The red lead, &c., added does not, of course, *preserve* the colour of the Cayenne, but simply supplies the place of that which it loses in consequence of exposure.

Fig. 142.



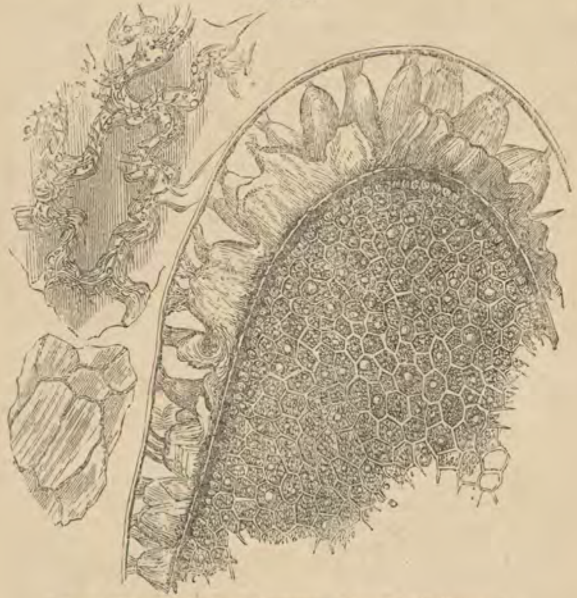
Transverse Section of CAPSICUM Berry. Magnified 100 diameters.

Salt is employed for the same purpose. This substance has a remarkable effect in bringing out the colour of the Cayenne. It is, however, also used to increase its weight.

The adulteration of Cayenne with such substances as red lead and mercury is, doubtless, highly prejudicial to health; it has been stated that colic and paralysis have both been produced by the use of Cayenne containing red lead.

The salts of lead and mercury are characterised by the circumstance that they are apt to accumulate in the system, and finally to produce symptoms of a very serious nature. Thus, no matter how small the quantity of mercury or lead introduced each day, the system is sure in the end, although it be slowly and insidiously, to be brought under the influence of these poisons, and to become seriously affected. The quantity of red lead introduced into the system in adulterated Cayenne is, however, *by no means inconsiderable.*

Fig. 143.



Vertical Section of the *Seed* of CAPSICUM. Magnified 100 diameters.

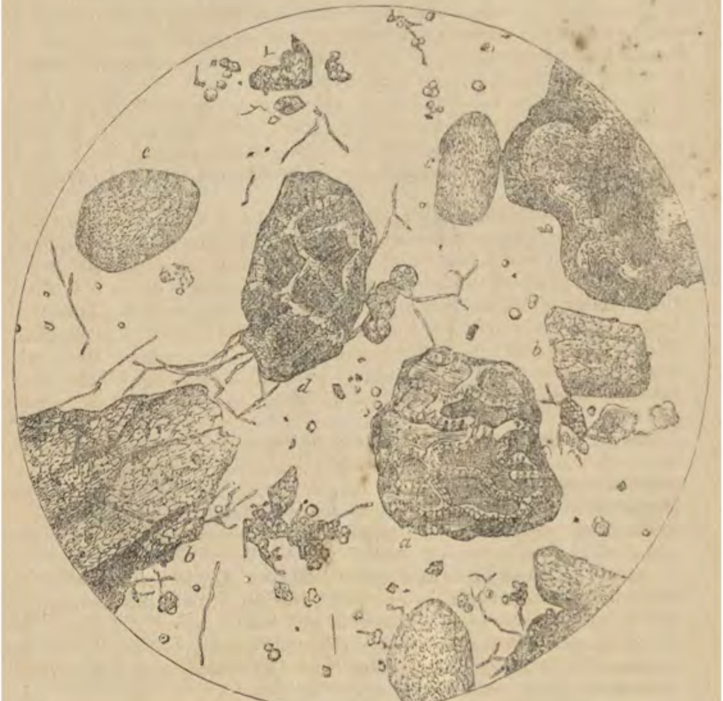
A case of lead poisoning arising from the consumption of Cayenne adulterated with red lead is referred to in the evidence of Mr. Postgate before the Parliamentary Committee on Adulteration; the case was received into University College Hospital. The man was in the habit of consuming large quantities of Cayenne, which, on being tested, was found to contain lead.

The article known as soluble Cayenne was stated by Mr. Scanlan, before the Parliamentary Committee, to have the following composition:—"It contains both copper and vermilion; the copper is accidentally introduced into it from the mode of preparation—it is taken from a copper still. They make a sort of tincture of the Cayenne pepper; and they filter and pour it upon a quantity of salt in a copper still — it there takes up a little copper; and then this salt is dried and mixed with vermilion and rose-pink." The proportion of vermilion added is about six drachms to three pounds of salt.

On the Detection of the Adulterations of Cayenne.

The adulterations of Cayenne with *rice flour*, *turmeric*, and *mustard husk*, are determined by means of the microscope; the structure of these articles have already been described and their microscopical characters represented.

Fig. 144.



CAYENNE, adulterated with, *a a*, *red lead*; *b b*, ground *rice*; and *c c*, *turmeric*. *d d*, husk and seed of *Cayenne* much infested with the *thallus* and *sporules* of a *fungus*, to the attacks of which damaged Cayenne is very subject.

For the detection of the other adulterations of Cayenne, recourse must be had to chemistry. The fact of the presence of red earths may indeed be ascertained by means of the microscope, by viewing under that instrument a portion of the Cayenne, when the red earthy particles may be plainly discerned. To determine their composition, however, chemistry must be appealed to.

The method for detecting the presence of red earths, and for their quantitative determination, will be found described at pp. 103. and 149., and that for salt under the head of annatto. We have, then, now to describe more particularly the processes to be followed for the detection of lead and mercury.

On the Detection of Lead.—The presence of lead in Cayenne may be determined by simply shaking up half a drachm or so of the Cayenne in water, and adding a few drops of hydrosulphuret of ammonium; if lead be present the liquid will become more or less dark or black, according to the quantity of lead present.

But it should be remembered that iron gives a greenish-black precipitate with the above-named reagent; and therefore it is not quite safe to trust in all cases to the appearance presented on the addition of solution of hydrosulphuret of ammonium to water containing Cayenne.

It is best, therefore, in all cases to proceed as follows:—Incinerate 100 grains of Cayenne previously dried on a water bath; treat the ash with about half a drachm of strong nitric acid; heat nearly to dryness, so that part of the acid may become dissipated; dilute with distilled water, filter, and test for lead either by means of sulphuretted hydrogen, hydrosulphuret of ammonium, or else iodide of potassium. When the quantity of lead present has to be determined, these reagents must be added until no more precipitate falls down; the precipitates must be collected, dried, weighed, and the red lead calculated.

On the Detection of Bisulphuret of Mercury.—As *mercury* sublimes at a red heat, we cannot proceed in the analysis by incineration; the solvent must be added to the Cayenne direct; and this solvent must consist of aqua regia, which is a mixture of nitric and hydrochloric acids, in the proportions of one part of the former to two of the latter acid.

About a scruple of aqua regia should be added to half a drachm of Cayenne, and after an hour or two a small quantity of distilled water; the mixture must next be filtered, and the excess of acid got rid of by evaporation, which must be conducted nearly, but not quite, to dryness; a little water must then again be added, and the solution tested.

The tests employed are liquor potassæ and iodide of potassium. The former gives a yellow precipitate, and the latter either a yellow or more commonly a beautiful scarlet-coloured precipitate of biniodide of mercury. The colour produced on the addition of iodide of potassium would always be bright scarlet, were it not that the presence of organic matter in the solution modifies the action of the test. The solution of iodide of potassium should be added in very minute quantity, as the iodide or biniodide is readily and almost instantly dissolved in an excess of this reagent; and it should be known that very often, when the colour of the precipitate is rather yellow than red, after standing an hour or two it will frequently change to the characteristic scarlet hue.

Cayenne pepper, ground Chili, and capsicum pods, are charged alike by the Customs — the pepper duty of 6*d.* per lb. and 5 per cent. thereon.

We have not been able to procure returns of the quantities imported. It is evident that the loss to the revenue in the adulteration of this article must be very great. We have never heard of any proceedings instituted by the Excise for the adulteration of Cayenne.

CURRY POWDER, AND ITS ADULTERATIONS.

Several ingredients enter into the composition of curry powder. The articles of which genuine curry powder of good quality ordinarily consists are turmeric, black pepper, coriander seeds, Cayenne, fenugreek, cardamoms, cumin, ginger, allspice, and cloves. Of these, turmeric forms the largest proportion; next to this in amount are coriander seeds and black pepper; Cayenne, cardamoms, cumin, and fenugreek, form but a small portion of the article; while the ginger, cloves, and allspice are in many cases omitted.

The properties and structure of several of the above ingredients have been already fully described and illustrated; as turmeric, black pepper, Cayenne, ginger, cloves, and allspice; it thus only remains to give a description of the other ingredients which enter into the composition of curry-powder—namely, coriander seeds, cardamoms, fenugreek, and cumin seeds.

Coriander Seeds.

Coriander (*Coriandrum sativum*) belongs to the natural family Umbelliferæ; it is an annual plant of a foot or a foot and a half in height; it is cultivated in Essex, and, although not really indigenous, is frequently met with growing wild in the neighbourhood of Ipswich and some parts of Essex.

The fruit or seed vessels are globular, about twice the size of white mustard seeds, and of a light-brown colour. Each fruit consists of two hemispherical portions termed *mericarps*, each of which is a seed;

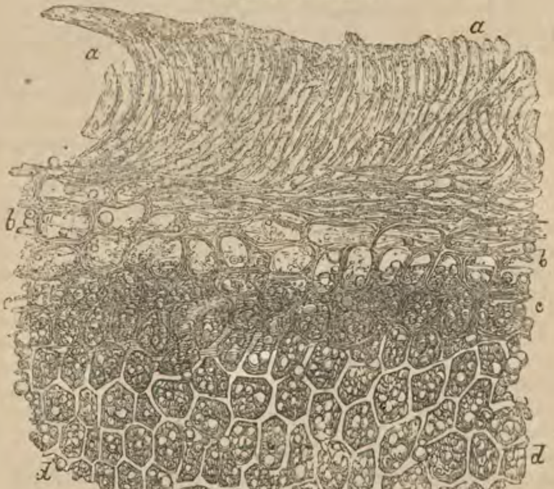
each mericarp exhibits on its outer surface five *primary* ridges, which are depressed and wavy, and four *secondary* ridges, which are more prominent and straight. The channels are without receptacles for the essential oil, or, as they are technically termed, *vittæ;* but near the commissures in each mericarp there is a small vitta, so that each fruit is provided with four of these receptacles.

The epidermis or husk is thick and brittle; when examined with the microscope, it is observed to consist of narrow fibres, which cross each other, and are disposed in a waved manner. It is united to the seed by means of loose cellular tissue, the cavities of the cells being empty. On the removal of the husk, these cells are torn through, some remaining attached to it, and the rest to the surface of the seed. After the separation of the husk, the seed is still of a brown colour. Beneath the cells above described succeeds a delicate fibrous membrane; and next to this is a layer of deeply-coloured cells, which merge into the cells which form the substance of the seed; these are angular, with

Fig. 145.

TRANSVERSE SECTION OF MERICARP OF CORIANDER.

(Magnified 220 diameters.)



a a, fibres forming the husk. *b*, the loose cells which unite the husk to the seed. *c*, the layer of deeply-coloured cells, in contact with the seed. *d d*, cells composing the seed itself.

well-defined parietes, their cavities enclosing oil in a molecular condition. The mature seed does not contain starch. *Fig.* 145.

The peculiar structure of the husk of coriander seeds affords a means by which their presence in curry powder may be readily determined.

Cardamom Seeds, or Grains of Paradise.

The seed vessels or pods of cardamom are of a triangular form, and consist of three valves, tapering at either extremity to a blunt point: the membrane forming them is thick, tough, and fibrous, and is made up of cellular tissue and bundles of woody fibre, which spread out from the flower-stalk, and are visible on the surface to the naked eye, imparting the striated appearance characteristic of the seed vessel of cardamom.

From its interior, the seed vessel sends off three prolongations or septa, which divide it into as many compartments; each of these contains several hard seeds of a reddish brown colour and exhibiting upon the surface peculiar markings. The seeds are united together by a gelatinous parenchymatous substance, which, under the microscope, is seen to consist of numerous delicate tubules, filled with granular and oily matter.

The covering of the seed, examined with the microscope, and viewed on its outer surface, is observed to consist of a single layer of coloured cells, much elongated, and of uniform diameter, terminating in rounded extremities, the cells being accurately adapted to each other. Beneath these are other cells, which bear a general resemblance in form to those previously described, but differ in being more irregular, much more delicate, and in the absence of colour: they are disposed in an opposite direction to those of the outer layer. *Fig.* 146. *A.*

In transverse sections, the elongated coloured cells appear as small canals, of a rounded form.

Lying beneath the coating, and forming part of the seed, is a single row of large cells, resembling receptacles. Next in order from without inwards is a layer of small cells, deeply coloured. Next to these succeed the cells which constitute the principal part of the seed; these for the most part resemble closely the cells of pepper, being very angular, but they differ in their more delicate and transparent appearance, and in being minutely dotted.° *Fig.* 146. *B.*

Dr. Pereira, in his "Materia Medica," quotes the statement made by Schleiden, that he has discovered in the cells of cardamom "amorphous, paste-like starch." We find the cells to be completely filled with minute, distinctly-formed starch granules, resembling closely those of rice. Probably the statement of M. Schleiden arose from his having employed but a feeble magnifying power in the examination of the seeds.

The presence of cardamom seeds in curry powder is most readily determined by means of the dotted and angular cells which form the substance of the seeds.

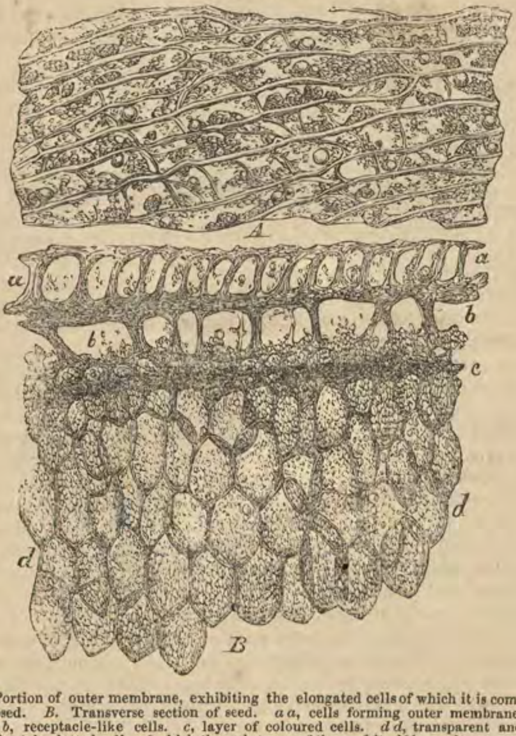
Cumin Seeds.

The cumin plant (*Cuminum Cyminum*) belongs, like coriander, to the natural order Umbelliferæ; is a native of Upper Egypt, but is extensively cultivated in Sicily and Malta.

Fig. 146.

OUTER MEMBRANE AND TRANSVERSE SECTION OF A CARDAMOM SEED.

(Magnified 220 diameters.)



A. Portion of outer membrane, exhibiting the elongated cells of which it is composed. *B*. Transverse section of seed. *a a*, cells forming outer membrane. *b b*, receptacle-like cells. *c*, layer of coloured cells. *d d*, transparent and minutely-dotted cells, of which the substance of the seed itself is made up, and which are filled with starch corpuscles.

Cumin seeds resemble somewhat caraway seeds, but they are larger, straighter, and of a lighter colour. The fruit is double, like that of coriander and all other umbelliferous plants, consisting of two seeds or mericarps; each mericarp has five *primary* ridges, which are filiform, and four *secondary* ridges, which are prominent; but both are furnished with very fine hairs or prickles, and under each secondary ridge is a receptacle or vitta.

Transverse sections of a cumin seed exhibit the following structure:—

The hairs or prickles are composed of cells, the long diameters of which are arranged in the long axes of the hairs. The husk or covering of the seed is made up of numerous rounded or angular cells, in the midst of which the large and triangular vittæ are situated; and between the husk and seed itself, there is usually a small space, which is formed by the contraction of the seed after it has arrived at maturity. The surface of the seed is of a pale-brown colour, and its interior whitish and transparent. The exterior portion of the seed is constituted of elongated and flattened cells of a brownish colour, while the interior and chief substance of the seed itself is composed of numerous distinct angular cells, the walls of which are thick and perfectly transparent; their contents consist principally of oil. The seeds do not contain starch. *Fig.* 147.

Cumin seeds possess a very peculiar, medicinal taste and smell; and it is to these that curry powder owes the greater part of its characteristic flavour and odour.

Fenugreek Seeds.

The structure of Fenugreek seeds is very characteristic. The husk of the seed consists of three membranes; the outer is formed of a single layer of cells, which bear a remarkable resemblance in shape to a short-necked bottle; the long diameter of these cells is disposed vertically, the narrow, neck-like part being most external, and forming the other surface of the membrane. The second membrane consists of a single layer of cells, two or three times larger than the former, very much flattened, and having their margins regularly and beautifully crenate. The third and innermost membrane is made up of several layers of large transparent cells filled with mucilage; these cells expand greatly when immersed in water. *Fig.* 148.

The seed itself consists of two lobes, which are made up of numerous minute cells; those in the outer part of each lobe are of a rounded or angular form, while those situated near the innermost part become much elongated, the long axes of the cells being placed transversely in each lobe. The entire seed is covered by a single layer of small angular cells. *Fig.* 149.

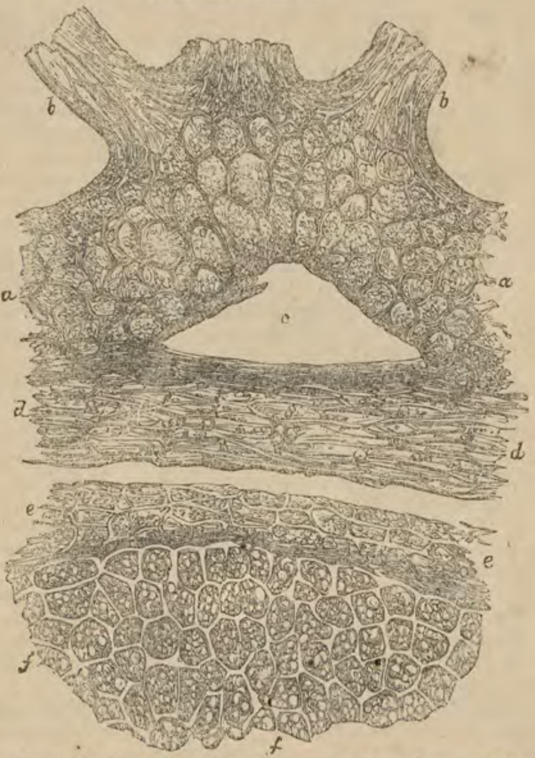
On the Adulterations of Curry Powder.

In various works which we have consulted, we do not meet with a single remark relating to the adulteration of curry powder. Like many of the other articles of which we have treated, this appears to have been neglected by writers on the adulteration of food.

Fig. 147.

Transverse Section of Mericarp of Cumin.

(Magnified 220 diameters.)



a a, cells forming the husk. *b b*, commencement of two hairs or prickles. c, receptacle or vitta. *d d*, elongated cells which compose the innermost layer of husk. c c, cells and fibres of which the external surface of the seed is formed. *f f*, cells of the seed itself, containing oil.

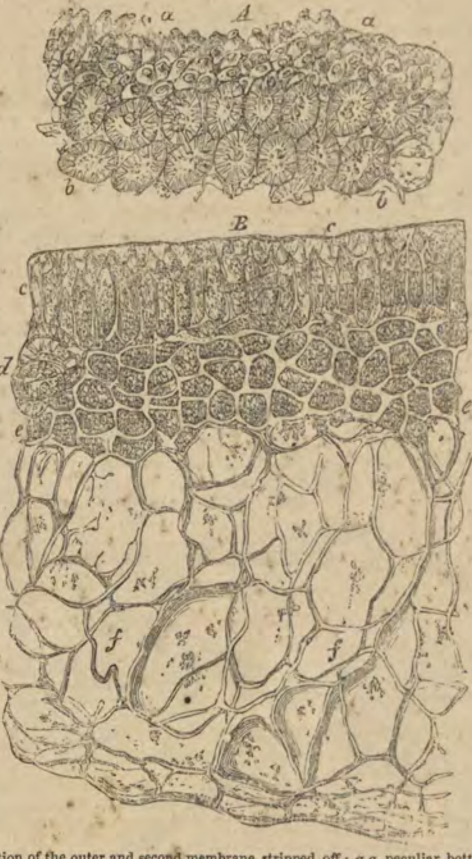
Results of the Examination of Samples.

Twenty-six samples of this article were subjected to analysis; of these *nearly four-fifths were adulterated.*

Fig. 148.

OUTER COAT OR TESTA OF A FENUGREEK SEED.

(Magnified 220 diameters.)



A. Portion of the outer and second membrane stripped off; *a a*, peculiar bottle-like cells; *b b*, crenated cells of second membrane. *B*. Transverse section of husk of seed; *e c*, bottle-like cells; *d*, position of crenated cells; *e e*, layer of coloured cells merging into, *f f*, the large cells which form the innermost membrane, filled with mucilage.

It appeared

That *seven* only were *genuine.*

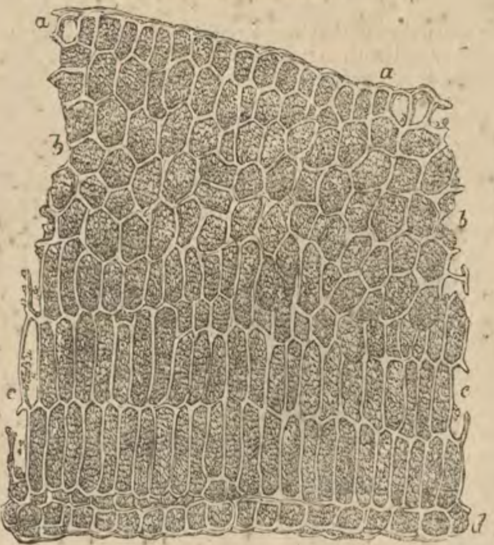
That *nineteen* were *adulterated.*

That *ground rice*, usually in very large quantities, was present in *nine* samples.

Fig. 149.

TRANSVERSE SECTION OF LOBE OF FENUGREEK SEED.

(Magnified 220 diameters.)



a a, layer of small angular cells on the surface. *b*, rounded or angular cells. *c*. The same cells gradually becoming more elongated as they approach the inner part of lobe. *d*, single row of cells forming the innermost margin of lobe.

That *potato farina* was detected in *one* sample.

That *salt* was present in *eight* of the samples.

That the highly poisonous metallic oxide, RED LEAD, was detected in no less than *eight* of the samples.

That in *seven* of the samples, the adulteration consisted of *ground rice* only.

That in *one* sample, the adulteration consisted of *ground rice* and *salt.*

That in *one* sample, the adulteration consisted of *ground rice* and RED LEAD.

That in *three* samples, the admixture consisted of *salt only.*

That in *three* samples, the adulteration consisted of *salt* and RED LEAD.
That in *three* samples, the adulteration consisted of RED LEAD only.
That in *one* sample, the adulterations consisted of RED LEAD, *potato farina* and *salt.*

The above results do not give the whole of the adulterations to which the samples of curry powder had been subjected, since they do not include the ferruginous earths, which were shown, in our article on Cayenne, to be so frequently employed to impart colour to that substance.

We have thus shown that curry powder is adulterated nearly to the same extent, and with ingredients equally pernicious as Cayenne. Since the quantity of curry powder eaten at a meal is so considerable, its adulteration with red lead is even more prejudicial and dangerous than in the case of Cayenne. Not long since we received a parcel of curry powder from a surgeon, accompanied by the statement that the person who had partaken of it had been made very ill by it. We found it, on analysis, to contain a large quantity of lead.

The lead in curry powder is, no doubt, generally introduced through the adulterated Cayenne employed in its manufacture. It is possible, however, that chromate of lead may here, as in some other cases, be used to intensify and render more permanent the colour of the powder.

The whole of the ingredients required for making curry powder may be obtained of most seedsmen, and may be readily procured of Mr. Butler, of Covent Garden Market.

With a common pestle and mortar the seeds may be reduced to powder, and thus the housekeeper may herself prepare genuine curry powder, of the best quality, at a cost of about 2*d.* per ounce. Since curry powder is retailed at 6*d.*, 8*d.*, and even 1*s.* an ounce, it evidently bears an enormous profit. What, then, must be the gain upon the sale of an article which is made up principally of turmeric powder, salt, ground rice, and inferior capsicum berries? and of such a mixture many of the curry powders purchased at the shops almost entirely consist.

On the Detection of the Adulterations of Curry Powder.

The adulterations of curry powder, with the exception of potato farina or starch, met with in one sample, being the same as those of Cayenne, the methods for their discovery are also the same; the reader is therefore referred to the previous article on Cayenne.

The presence of potato starch is detected by means of the microscope; the characters of its granules are described under the head of Arrowroot.

Curry powder is charged by the Customs, as a manufactured article unenumerated, at 10 per cent. *ad valorem.*

TURMERIC, AND ITS ADULTERATIONS.

Turmeric powder consists of the ground tubers of a plant belonging to the same genus as ginger, viz., *Curcuma longa*, and which is extensively cultivated in India and China.

Composition of Turmeric.

The composition of turmeric is shown in the following analysis:—

John's Analysis.

Yellow volatile oil	1
Curcumin	10 to 11
Yellow extractive	11 to 12
Gum	14
Woody fibre	57
Water and loss	7 to 5
	100

Vogel and Pelletier's Analysis.

Acrid volatile oil.
Curcumin.
Brown colouring matter.
Gum (a little).
Starch.
Woody fibre.
Chloride of calcium.
Turmeric.

The word *curcumin* is applied to the resinous colouring matter of turmeric, which is soluble only in ether.

Structure of Turmeric.

The structure of the tuber of turmeric is well exhibited in the annexed figures.

Turmeric powder consists of large cells; some of these are loosely imbedded in a reticular tissue, but others, and these the majority, are quite free; they may be recognised with facility, under the microscope, by their size and bright yellow colour.

When crushed, each cell is found to contain colouring matter, as well as a number of starch granules, resembling closely those of Curcuma arrowroot, already described and figured.

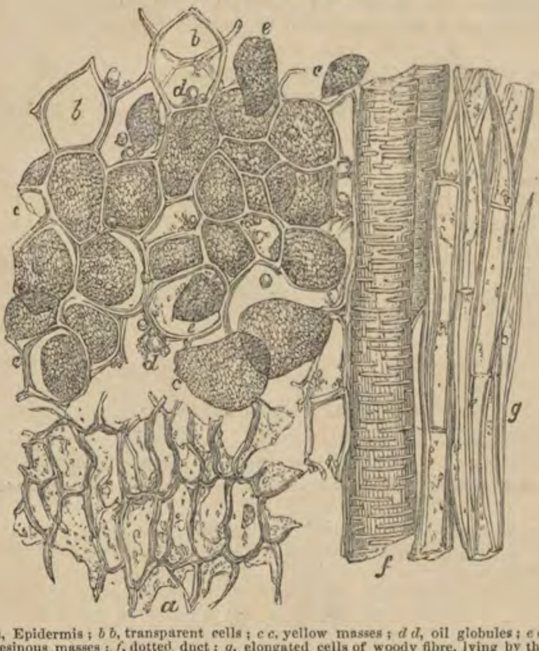
On the application of iodine the cells become of a deep blue, and with potash, of a reddish colour.

ON THE ADULTERATIONS OF TURMERIC.

Of *Fourteen* samples of turmeric powder subjected to examination, two were adulterated with *yellow ochre,* to the extent of nearly 20 per cent., while nearly all the other specimens contained considerable quantities of *alkali*, carbonate of soda and potash, added no doubt to heighten the colour of the powder.

Fig. 150.

SECTION OF TUBER OF TURMERIC.



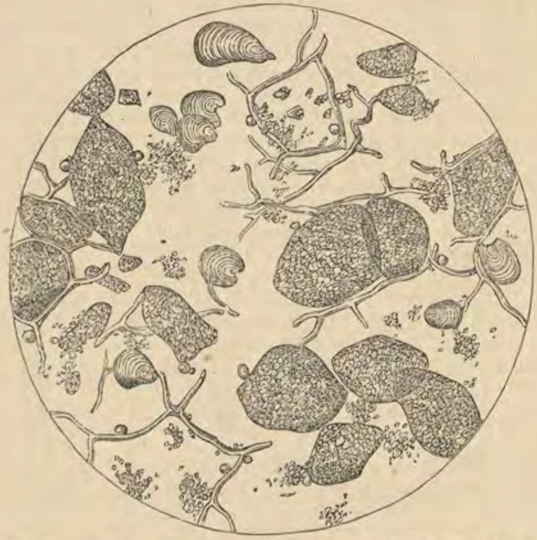
a a, Epidermis ; *b b*, transparent cells ; *c c*, yellow masses ; *d d*, oil globules ; *e e*, resinous masses ; *f*, dotted duct ; *g*, elongated cells of woody fibre, lying by the side of the duct.

Inasmuch as turmeric enters so largely into the composition of curry powder, mustard, and some other condiments, it became necessary to ascertain whether it was liable or not to sophistication.

On the Detection of the Adulterations of Turmeric.

Yellow ochre consists of oxide of iron diluted with chalk ; the ash of turmeric powder must therefore be tested in the manner already directed for the detection of those two substances. The presence of the ochre is in general sufficiently indicated by the colour and weight of the ash.

Fig. 151.



This engraving represents the appearance and characters of *genuine ground* TURMERIC. Drawn with the Camera Lucida, and magnified 220 diameters.

Should the ash, say of 100 grains of the turmeric, contain alkali, as carbonate of soda or potash, we must proceed as follows: the alkali must be dissolved out of the ash by means of distilled water, the solution evaporated down to a small bulk, and heated with excess of dilute hydrochloric acid; the solution must now be diluted, and the chlorine precipitated by means of nitrate of silver; the precipitate collected, dried, weighed, the chlorine estimated and calculated into carbonic acid, and this again into either carbonate of soda or potash, according to whichever is present, and which may be ascertained by means of the blowpipe; this gives with soda a rich yellow, and with potash a violet flame.

If the potash be mixed with even one-twentieth part of soda, the flame will be yellow in place of violet. In this case it will be necessary to proceed as follows: the hydrochloric acid solution is to be evaporated to dryness and weighed, the residue dissolved in a little water; to this is to be added a small quantity of solution of bichloride of platinum, the mixture is to be evaporated nearly to dryness on a water-bath, and the residue treated with successive small portions of alcohol, which will dissolve out the excess of bichloride of platinum used, as well as the chloride of sodium, leaving the double chloride of platinum and potassium, which is known by its lemon-yellow colour, and which may be further tested with the blowpipe.

It is always well to test, before commencing the analysis, the reaction of the watery solution of the ash, as, unless this is decidedly alkaline, it does not contain alkali, and again it is proper also to test the ash, to ascertain whether salt has been used, and which is sometimes employed to heighten the colour of vegetable powders. Very generally the presence of alkali in the ash of turmeric powder is sufficiently indicated by the greenish colour, more or less intense, exhibited by it when first removed from the fire.

Supposing both soda and potash are present, and we desire to determine the quantities, the chloride of platinum and potassium must be dried in a weighed filter, weighed when dry, and the chloride of potassium must be calculated from this: the difference between the weight of the combined chlorides and that of the chloride of potassium gives that of the chloride of sodium.

Turmeric is duty free. Imported in 1854, 64 tons; and in 1855, 27 tons.

VINEGAR, AND ITS ADULTERATIONS.

Acetic acid is the volatile principle, to the presence of which, diluted with variable proportions of water, vinegar owes its aroma and pungency.

This acid exists, ready formed, in notable quantity in certain plants, as *Sambucus niger* or *black elder*, *Phœnix dactylifera* or *Date tree*, and *Rhus typhenus*.

It may be readily generated by the fermentation of various vegetable and animal substances, especially the former.

For commercial purposes it is made from certain vegetable and spirituous infusions, as those of the grape, malt, and the sugar cane; but any vegetable infusion capable of yielding alcohol will also, when exposed to the necessary conditions, furnish vinegar. In most cases, and indeed whenever vinegar is manufactured on a large scale, the vinous or alcoholic fermentation precedes the acetous, and the vinegar is formed entirely at the expense of the alcohol.

But the conversion of alcohol into acetic acid, it is said, ought not to be regarded as essential to acetification, since some vegetable and animal infusions become sour, from the formation of acetic acid, without any previous generation of alcohol.

Acetic acid may be formed directly from the vapour of crude alcohol or spirits of wine in communication with the atmosphere, through either an ignited platinum wire, or by means of the black powder obtained by boiling proto-chloride of platinum and potash with alcohol. In Germany, where the price of alcohol is very low, vinegar has been manufactured on a large scale on this principle. The process will be found described at page 368. of "Food and its Adulterations."

Certain conditions are either essential to acetification, or else promote greatly the rapidily of the process; thus the presence of *atmospheric air* or *oxygen* is one of the conditions indispensable to the change, the reason of which is made apparent by the subjoined formulæ:—

One atom of alcohol consists of

$$C_4\,H_5O+H\,O;$$

One atom of anhydrous acetic acid of

$$C_4\,H_3\,O_3.$$

Now, one atom of alcohol absorbs four atoms of oxygen from the air, to form one atom of anhydrous acetic acid, and three atoms of water—a change which is thus explained by chemical symbols.

$$C_4\,H_6\,O_2 \text{ and } 4\,O = C_4\,H_3\,O_3 \text{ and } 3\,H\,O;$$
$$\text{or } C_4\,H_5\,O + H\,O \text{ and } 4\,O = H\,O,\,C_4\,H_3\,O_3 + 2\,H\,O.$$

Thus, when alcohol is converted into acetic acid, two of the atoms of the oxygen are directly absorbed to form the acid, and the remaining two atoms convert two atoms of the hydrogen of the alcohol into water; the atom of water of the alcohol and the two fresh atoms of water produced are all retained, and form a terhydrate of acetic acid.

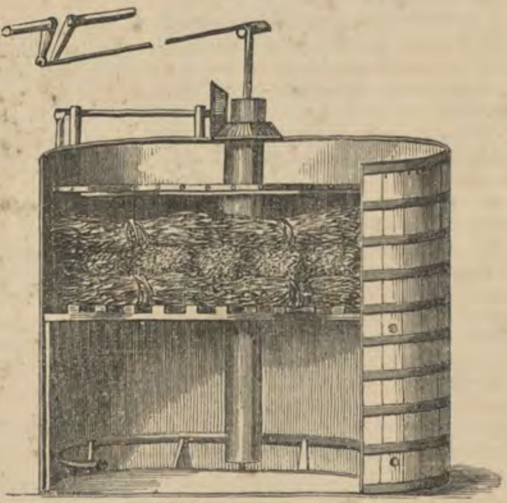
Such are the changes, by atom, of alcohol into acetic acid.

It is therefore evident that much of the success of any process adopted for the manufacture of vinegar will depend upon the manner in which the mother liquor is exposed to the atmosphere—that is, upon the constant renewal of the air, and the extent of surface exposed to its action, the conversion of alcohol into acetic acid taking place only on the surface of the liquid.

The knowledge of the fact that atmospheric air was indispensable to acetification led to the adoption in this country and in Germany of what has been termed "*the quick vinegar process*," by which the liquid to be converted into vinegar is kept constantly in motion in a divided state, and thus a large surface is continually exposed to the action of the atmosphere.

Some time since we had the opportunity of seeing this improved process in full operation at the vinegar manufactory of Messrs. Hill, Evans, and Co., of Worcester.

Fig. 152.



ACETIFIER MODEL.

In the manufactory of the firm above named the process is conducted in large vats, capable of each holding from 6,000 to 10,000 gallons of wash; each vat is half filled with the liquid to be acidified, and the upper half with bundles of birch, such as are in general use for brooms or besoms. The pump in the centre elevates the liquor, and, by means of its rotative motion, disperses it in a shower over the surface of the bed of birch, and in descending through the same it is met by a small ascending current of atmospheric air, which, coming in contact with the multiplied surfaces of the liquor trickling through the twigs, speedily acidifies it; the whole being kept up to the proper heat by a steam pipe of pure tin passing through the vat. The acidification is generally completed in twenty days, but varies in inverse ratio to the proportion of birch to the wort to be acidified; and the whole operation, mechanical and chemical, being performed by steam, no manual labour of any kind is required, save the occasional inspection of the manager to ascertain when the process is finished.

This apparatus is capable of acidifying any fermented liquor whatever, and even distilled spirit, with a complete control over any waste.

The process will be more clearly comprehended by an examination of the accompanying engraving, which was made from a model prepared by Messrs. Hill, Evans, and Co., and shown at the Great Exhibition.

The upper circular opening in the side of the vat is for the admission of atmospheric air, the lower is the termination of the steam pipe. It should be mentioned that the principle of the process was discovered quite independently, and about the same time, in Germany and in this country.

A second necessary condition is the presence of a substance capable of exciting fermentation — that is, a *ferment.*

In vegetable infusions, as those of the grape and malt, the nitrogenised principles contained in them, chiefly gluten, act as the ferment. Vinegar itself, vinegar yeast, lees, beer yeast, leavened bread, and many other similar matters, all of which contain gluten, are capable of exciting fermentation, and so promoting the generation of acetic acid. Experience has shown that the best ferment for inducing the transformation of alcohol into acetic acid is a portion of ready-made vinegar itself.

A third condition, which, though not, like the former, essential, yet greatly hastens the conversion, is an increased temperature, varying considerably in different cases, but sometimes reaching as high as 100° Fahr.

When any spirituous liquor is exposed under the conditions requisite for acetification, the following phenomena are observed to occur in succession.

However clear the liquid may have been at first, it quickly becomes turbid, currents or movements are soon visible in it; it is said, in common language, to be "on the work." Slimy particles collect on the surface, gradually forming a scum, and which, after a time, falls as a sediment to the bottom. The Germans call this scum "vinegar mother," since it is capable of exciting acetification in fresh portions of liquid. During the process the temperature of the liquid rises, and the peculiar aroma of vinegar becomes diffused in the surrounding air; as soon as all the alcohol has become converted into acetic acid, the temperature falls to that of the atmosphere; the motion ceases, the liquid becomes clear and bright, and its conversion into vinegar is complete.

THE DIFFERENT KINDS OF VINEGAR AND THEIR MANUFACTURE.

The four principal kinds of vinegar met with in commerce are — *wine vinegar*, *malt vinegar*, *sugar vinegar*, and *wood vinegar.* The first three of these depend upon fermentation, and result from the change of alcohol into acetic acid; while wood vinegar is obtained without the intervention of fermentation, by the destructive distillation of wood.

Not unfrequently more than one substance is combined in the manufacture of vinegar; thus, mixtures of malt, corn, and sugar or treacle are occasionally employed; in which case the resulting vinegar is of course a combination of two or more kinds of vinegar.

In some parts of England vinegar is made from either *cider* or *perry;* these kinds are distinguished by the presence of malic acid.

Distilled vinegar may be obtained by the distillation of any kind of vinegar; what is commonly sold however as this, is generally nothing more than diluted acetic acid, and in some cases even pyroligneous acid.

Wine Vinegar, when pure and of good quality, is the best description of vinegar; it is liable, however, to adulteration with pyroligneous acid. It is sometimes flavoured by the addition of wine, and is distinguished from all other vinegars by the presence of bitartrate of potash, called usually tartar or wine-stone. The presence of the alcohol increases its aroma and pungency.

Owing to the scarcity and high price of French wine vinegar, it being three times as dear in France as formerly, and its consequent liability to adulteration, Messrs. W. and S. Kent and Sons, importers of French white wine vinegar, have been induced to prepare a vinegar, having as nearly as possible the flavour and properties of French wine vinegar. We have examined some specimens of this article, and find it to be carefully manufactured, perfectly genuine, and of strength quite equal to that of wine vinegar.

Malt Vinegar.—The chief part of the vinegar made in this country is prepared from malt, or from malt and corn, with or without sugar.

Sugar Vinegar.—An excellent vinegar may be made from sugar; the process is described at page 371. of "Food and its Adulterations."

A very pure and wholesome vinegar may also be prepared from a solution of sugar or treacle, fermented by the agency of a fungus termed "*the vinegar plant.*"

We were favoured some time back by Mr. Fletcher, surgeon of Bromsgrove, with the following particulars in reference to the vinegar plant:—

"A few weeks ago I had a young vinegar plant sent me, with the following directions:—'Put the plant in an earthen jar, add to it half a pound of the coarsest moist sugar, and half a pound of treacle, with five pints of milk-warm water; cover it lightly over, so as to keep out the dust, but not the air, and then put it in a moderately warm place; there let it remain seven weeks, not disturbing it more than you can help. At the end of that time pour off what is now the clear vinegar, and keep it in well-corked bottles for use. Again add to the plant the same quantity of water, sugar, and treacle, as before. At the end of the second seven weeks, the plant will have become like two thick pancakes, and they may be easily divided, care being taken not to tear the old or new plant. If the plant is exposed to the cold, or kept too long out of the liquid, it will become black and die.'

"I herewith send you," continues Mr. Fletcher, "a sample of vinegar thus manufactured. Should the sample be worthy of your attention, I will send you a larger quantity of vinegar, a young plant, and a sample of pickles made with this kind of vinegar."

In a second letter, Mr. Fletcher writes: "The plant I have, was given me early in the winter, and it not only has supplied me with several young plants for friends, but vinegar enough to last me for years."

We have been given to understand that vinegar plants are sold in large numbers by the chemists in Manchester and the surrounding towns, and that vinegar is made in considerable quantities by means of these fungi. We also know that since the publication of the fact that vinegar may be thus prepared, many persons have been led to try it, and for the most part with very satisfactory results.

Nearly all vinegar-makers supply at least four different strengths or qualities of vinegar, named respectively Nos. 24, 22, 18, and 16, the first being the strongest, and the last the weakest.

No. 24, or Standard vinegar, as it was called at the time when the Excise levied a duty on this article, is now seldom made; but when a very strong vinegar is required, the strength of the ordinary kind is raised by the direct addition of acetic or even pyroligneous acid.

No. 22 is in most cases the strongest vinegar really manufactured; the other and weaker kinds are not, however, prepared from this by the addition of certain quantities of water, but from separate worts, as it would not pay to make a weak vinegar by the dilution of a strong one.

Further, these numbers do not indicate *absolute*, but merely *relative* strengths, so that the vinegars of different makers having the same number vary considerably in the amount of acetic acid contained in them.

It is thus evident that, according to this system, much inducement for sophistication on the part of retail dealers is removed, who, if they wish to be supplied with a poor and cheap vinegar, have only to order a cask of the Nos. 18 or 16 vinegars of any of the makers.

It is generally stated that good vinegars, such as all Nos. 24 ought to be, should contain 5 per cent. of anhydrous or pure acetic acid.

The goodness of a vinegar is indicated to some extent by its specific gravity. No. 24 vinegar of good quality should have a specific gravity of not less than 1022, No. 22 of 1020, No. 20 of 1019, No. 18 of 1017, and No. 16 of 1015.

On the Adulterations of Vinegar.

The principal adulterations of vinegar are with *water*, *sulphuric acid* and *burnt sugar*, and sometimes with acrid substances, as *chillies* and *grains of paradise*, and also with *pyroligneous* or *acetic acids.*

The water is added to increase its bulk, sulphuric acid and acrid substances to make it pungent, and burnt sugar to restore the colour lost by dilution.

Some of the vinegars sold at small hucksters' shops, and at oyster stalls, consist of little else than diluted sulphuric acid and water coloured with burnt sugar.

Now, the law allows the addition of one part of sulphuric acid to 1000 of vinegar, and it is only when the quantity exceeds that amount that it can be considered as an adulteration; and this it very frequently does.

The use of this quantity of sulphuric acid was permitted on the plea, urged by the manufacturer, that it was necessary in order to make the vinegar keep. That it is not requisite to the preservation of well-made vinegar, is shown by the circumstance that several manufacturers, especially those who make use of the quick vinegar processs, do not use sulphuric acid at all; and yet the vinegar made by them keeps perfectly well.

As has already been noticed, the same practice prevails in the article vinegar as in mustard; no less than four, and even five qualities of vinegar are made, differing only in strength; the consequence of this system is, that if you buy vinegar at several different shops, it will be found that some of the vinegars will contain two or three times less acetic acid, the active ingredient of the vinegar, than others, although the same price is paid for them all. This system, therefore, affords great facilities for imposition.

Other adulterations described in books, the majority of which are probably of unfrequent occurrence, consist in the addition of *nitric*, *hydrochloric*, and *tartaric acids*, *alum*, *salt*, *spurge flax*, *mustard*, *pellitory*, and *long pepper*.

Vinegar is not unfrequently contaminated with arsenic, this being introduced through the sulphuric acid used in its adulteration.

"You get arsenic," states Mr. Scanlan in his evidence before the Parliamentary Committee, "in oil of vitriol to a great extent. This arises from the employment of pyrites instead of sulphur. Oil of vitriol is made in large quantities by alkali makers, and when the price of sulphur is high they use pyrites instead; and pyrites almost invariably contains arsenic. Irish pyrites contains a good deal; but I have understood that the Cornish pyrites contains still more. Some few years ago I found an enormous quantity of sulphuric acid here in London. It finds its way into muriatic acid made from that sulphuric acid, or in the manufacture of which that sulphuric acid is employed, and hence it may be very mischievous. A mixture of muriatic acid and soda has been used in bread, and I have seen muriatic acid containing a very fearful quantity of arsenic."

The following evidence in regard to the use of *corrosive sublimate* was given by Mr. Gay, before the Parliamentary Committee:—

"Corrosive sublimate has been used for years and years in some houses, and not a cask has gone out without a certain proportion of corrosive sublimate."

Chairman. "Do you believe that corrosive sublimate was mixed with the vinegar in injurious proportions?

"I do; it was done to give strength to the vinegar. When the D. W. and O. V. have been used, the corrosive sublimate is put in to give it a tartness again in the mouth."

Chairman. "Are these technical expressions in the trade—O. V. for oil of vitriol, and D. W. for distilled water?"

"Just so. Corrosive sublimate is called 'the Doctor.'"

White or distilled vinegar, as it is called, is usually made with water and acetic acid, what is sold as such being rarely distilled at all.

RESULTS OF ANALYSES OF SAMPLES.

The chemical analysis of *Thirty-three* samples of vinegar purchased of various tradesmen resident in London, furnished the following results:—

1st. That the amount of acetic acid, the most important constituent of vinegar, varies greatly in different samples, the highest percentage being 5·10, and the lowest 2·29, or less than half the first amount.

2nd. That, since the standard No. 24 vinegars, submitted to analysis, range for the most part considerably over four per cent., vinegar to be deemed good ought to contain certainly *not less* than four per cent. of real acid.

3rd. Judged by this standard, out of twenty-three samples of vinegar purchased of dealers in London, seven reached this strength, and contained from four per cent. upwards of acetic acid; the percentage of seven of the vinegars ranged between three and four while in the remaining nine the amount of acid varied from two to three per cent., it being in two instances—samples 17. and 19., the weakest of the whole—as low as 2·40 and 2·29.

4th. That twelve samples out of the thirty-three analysed contained no free sulphuric acid—a fact affording convincing proof that the use of this acid, so objectionable in many respects, is not necessary for the preservation of well-made vinegar.

5th. That in eight samples the quantity of sulphuric acid present did not exceed the amount formerly permitted to be added.

6th. That in the remaining cases the amount exceeded this, and in some instances was three or four times as great.

The results of the analysis of a *second series of samples*, *Twenty-eight* in number, of the vinegar of some of the principal vinegar manufacturers, were as follows:—

1st. That *seven* of the samples were entirely free from sulphuric acid, or oil of vitriol.
2nd. That *eighteen* were adulterated with that powerful and corrosive mineral acid, the amount of which was variable, and often very considerable; from ·63, the lowest, to 6·02, the highest quantity in 1000 grains.
3rd. That *two* of the samples contained it in very small quantity only.
4th. That in *three* samples it was present in considerable amount.
5th. That *six* contained it in very considerable amount.
6th. That in *seven* samples it was present in immense quantity.
7th. That the acetic acid also varied very considerably in amount in different samples, the highest proportion being, in 1000 grains by measure, 56·66 grains, or 5·66 per cent., and the lowest, 27·63, or only 2·76 per cent.
8th. That in *eight* samples, the acetic acid was present in amount over *five* per cent., which is above the standard strength.
9th. That in *twelve* samples the quantity exceeded *four* per cent.
10th. That in *seven* it was over *three* per cent.
11th. That in *one* the quantity of acetic acid present was so exceedingly small as to be *under three* per cent.,—that is, but little more than half the proper strength.

The sulphuric acid indicated in the analyses, is what is termed monohydrated sulphuric acid, which is in general very much stronger than the commercial acid: every part of the former, therefore, corresponds to a much larger quantity of the latter.

Again, it should be particularly remembered that the acidifying power of the mineral sulphuric acid is very much greater than that of the vegetable acetic acid: one part of sulphuric acid acidifies a much larger quantity of a fluid than the same amount of acetic acid, so that the sulphuric acid present in vinegar does not simply take the place of a similar quantity of acetic acid, but represents several times the amount of that acid.

As in the preparation of acetic acid, and distilled vinegar, copper stills, lead, zinc, or tin pipes are sometimes, though by no means commonly used, vinegar is occasionally found to be contaminated to a dangerous extent with those metals. As vinegar is capable of acting very energetically, in the course of a few minutes, on most metals, their use in its manufacture ought to be strictly prohibited: many fatal accidents have resulted from the impregnation of vinegar with metallic poisons. The metal which is, however, most frequently found in vinegar is iron.

On the Detection of the Adulterations of Vinegar.

The readiest means which can be adopted of ascertaining the quality of a vinegar is by determining its specific gravity; this may be done either by means of the ordinary hydrometer, or else by an instrument constructed on the same principles as the galactometer of M. Dinocourt already described. The ordinary gravities of vinegars of the several qualities are stated at p. 395. It will frequently be found that the vinegars sold at the shops weigh several degrees less than even No. 16. vinegar, which is the poorest made, and the specific gravity of which is usually 1015. When the gravity is below this, the vinegar is unquestionably adulterated with *water*.

On the Determination of the Acetic Acid in Vinegar.—The quality of a vinegar, and whether it is adulterated or not, can often be ascertained by determining the amount of acetic acid present in any sample; the determination is effected by saturation with known quantities of an alkali.

The acid may be first separated from the other constituents, impurities, or adulterations of the vinegar, by distillation; being volatile, it passes off on the application of heat, and is thus procured not only separately, but also in a more concentrated form. The quantity of vinegar to be employed is 10 ounces, which should be distilled almost to dryness, the acid obtained being then neutralised with alkali, and its amount thus determined.

The process of distillation, however, is tedious, and does not admit of easy application, except in the laboratory of the chemist. The same end can be attained by a different method: thus the alkali may be added directly to the vinegar. The alkali usually employed is soda; it may be used either in the form of the pure crystals of the carbonate, the recently ignited carbonate, which is preferable, or a solution of caustic soda. The dried carbonate is prepared by igniting the carbonate in a crucible. The whole of the water of crystallisation should be driven off, and the white powder left heated to redness.

Weighed quantities of the soda should be dissolved in known bulks of distilled water. In this way the re-agent may be applied in even decimal portions of a grain.

Further, it is not only necessary to prepare such a solution, but also to have the means of employing it in definite minute quantities,—an object which is effected by an instrument termed an alkalimeter.

An alkalimeter is an elongated and graduated glass tube, terminating above in two apertures, the one large, by which the instrument is replenished, and the other small, and drawn out into a point to regulate the escape of the fluid in drops. The instrument which we employ is one of Griffin's septimal alkalimeters; the scale is marked into ten principal divisions, which are again subdivided into ten lesser degrees or spaces, each of which is denominated a "septem," from its being made to contain seven grains of distilled water. The entire measure, therefore, holds, as will be perceived, seven hundred grains of distilled water. *

In many chemical works we are directed to mix a few drops of a strong solution of litmus with the vinegar, previous to using the soda solution, and to add this until the colour of the reddened litmus is restored. These directions are erroneous, and lead to serious miscalculations; for the litmus does not again become blue until the saturating point has been long passed, and the liquid has acquired a decided alkaline reaction; we therefore recommend the operator not to rely upon the indications afforded by solution of litmus.

Again, we are told to continue adding the soda solution until the litmus paper immersed in the vinegar ceases to turn red. There is here a source of error equally great as in the former case; for the litmus paper will be reddened long after the acetic acid has been neutralised, this arising from the disengaged carbonic acid of the soda, absorbed and retained by the fluid.

This fallacy is guarded against by repeatedly drying, in the course of the process, the litmus paper before the fire or the flame of a candle, when, if the redness be due to carbonic acid, it will vanish on the application of the heat; but if to acetic acid, it will be permanent. Another means of guarding against fallacy arising out of the presence of free carbonic acid is to heat the vinegar, and so expel the acid, or to set it aside for a few hours and thus allow of its escape. The saturation is complete, when the litmus paper neither retains the *slightest shade* of redness, nor has its blue tint in the least degree heightened, this latter indicating, of course, alkalinity. By the use, however, of the solution of caustic soda, the source of fallacy arising out of the disengagement of carbonic acid is avoided. The great objection to the caustic solution is, that it very quickly absorbs carbonic acid, and therefore will not keep for any length of time.

Mr. Mitchell, in his treatise on "The Falsifications of Food," states "that if a drop or two of pure vinegar be placed upon blue litmus paper, the latter will be reddened; but when dried before a fire, the red colour disappears, and the original blue again presents itself."

Although, from the volatile character of acetic acid, it might be inferred that this statement was correct, we have yet found that the redness produced by this acid is not dissipated by the degree of heat which is employed to dry the litmus paper, but on the contrary remains fast.

The strength of the solution should be determined by atom: one atom, or 1·03 of the recently-ignited carbonate of soda corresponds to, and will saturate one atom of, anhydrous acetic acid.

The soda should be added to the water in the proportion of six equivalents to one hundred grains of distilled water. If a pound of the solution be prepared, the same weight of water should be poured into a white glass bottle, the level of the liquid in the vessel being exactly ascertained and marked; the bottle should then be emptied, the soda dissolved in a portion of the water, and returned into the bottle, the remaining water being added up to the mark previously made, and any water that may be over being rejected.

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* An improved alkalimeter of Mohr is now made by Mr. Griffin, by means of which definite quantities of the solution may be added with greater accuracy.

An ammonia solution is free from the objections attached to the solution of carbonate of soda, when the precaution pointed out with respect to the use of the litmus paper is not strictly observed.

It is extremely difficult, however, to obtain a definite solution of ammonia, and when procured, to maintain it of uniform strength. Mr. Griffin, of Finsbury Square, perceiving the advantages of the ammonia solution, proposes to prepare it in such a manner as entirely to obviate these objections. An ingenious plan has been devised for noting loss of strength in a solution of ammonia. Two nicely-balanced beads are immersed in it: the one, so long as the solution is of the proper strength, remains at the bottom, but gradually ascends as the liquid becomes heavier; the other lies just under the surface of the fluid, and of course emerges from it, and makes its appearance above, under the same circumstances.

Some experimenters determine the amount of acetic acid by weighing the quantity of carbonic acid evolved. This method requires a special apparatus; and it is questionable whether, unless very carefully employed, it gives such accurate results as the soda solution.

A note must of course be kept of the quantity of soda solution used to neutralise the vinegar: from this the soda must be calculated, and from this again the acetic acid estimated: —

On the Determination of Sulphuric Acid in Vinegar. — Sulphuric acid, as we have said, is very commonly added to the malt and other vinegars made in this country, ostensibly for the purpose of making it keep better, but also unquestionably to augment its strength.

We have already expressed doubts as to whether this addition is at all necessary to well-manufactured vinegar, since some makers dispense with it altogether; as, however, the law has allowed of the addition of a certain amount of sulphuric acid, the presence of this can hardly be treated as an adulteration, although strictly it really is so. By it the acidity of the vinegar is not only increased, but the cost of the article much reduced, and in place of a volatile and aromatic acid, such as is natural to the gastric juice, we are made to consume a harsh mineral acid, having none of these properties, and in no way concerned in digestion.

Several statements are contained in books which treat of adulterations, respecting the detection of sulphuric acid in vinegar. Thus, it is said: —

First. If a pen be charged with vinegar containing sulphuric acid, and words written with it, when dried before the fire, they turn black.

Second. When such vinegar is dropped on paper, the spots also become black when dried.

Third. That towards the conclusion of the evaporation of a portion of vinegar containing sulphuric acid, dense fumes of sulphureous acid will be evolved, and the residuum charred.

Fourth. If a drop of the vinegar be allowed to fall into a hot solution of cane sugar, an intense black spot will instantly appear, resulting from the carbonisation of the sugar.

Fifth. That starch or dextrine, being boiled in vinegar containing sulphuric acid, will be converted into glucose, or grape sugar.

Mr. Lewis Thompson adopts the following process for the detection of free sulphuric acid in vinegar, by which as small a quantity as one half per cent. of that acid, he states, may be detected:—"It will be seen, by only exposing a single drop of the vinegar upon a little plate at a steam heat for five minutes, the vinegar containing the sulphuric acid will become perfectly black. A small white plate is put over a vessel containing water, and the water is made to boil, so that the steam plays against the lower part of the plate. Under these circumstances, take a drop of the suspected vinegar, and drop it upon the plate; if it contains oil of vitriol, the vinegar will evaporate, and the acid will concentrate, till it is sufficiently strong to act on the organic matter of the vinegar, on which it acts and chars it."

For the determination of the sulphuric acid quantitatively, either of the two following methods may be adopted.

Solution of nitrate of baryta may be added gradually to 500 grains of the vinegar contained in a tall precipitating glass until no further precipitate falls, the vinegar being well agitated after each addition, and an interval of an hour or so being allowed to lapse, to permit of the subsidence of the sulphate of baryta, before a fresh quantity of the solution is added. The quantity of sulphuric acid is determined from the amount of solution used.

A better method is to add excess of the baryta solution. The precipitate may be separated either by filtration or decantation, the latter being in many cases preferable; it must then be washed, ignited, weighed, and the sulphuric acid calculated from it in the form of the monohydrated acid:

As the *combined* sulphuric acid by this process, as well as that which is *free*, are thrown down, it becomes necessary to ascertain the quantity of sulphuric acid in the state of combination present in genuine vinegar. With this view we have analysed different samples, of 1000 grains each, of pure vinegar, and obtained the following amounts of sulphate of baryta:—from Kent's Bordeaux, 61 hundredths of a grain; Kent's No. 17., 57 hundredths; and from Gilbert's pickling vinegar, 46 hundredths; the first corresponding with 25, the second with 24, and the third with 19 hundredths of sulphuric acid. In all calculations, therefore, the average quantity of combined sulphuric acid should be deducted from the total amount of that acid present.

In some instances, where very hard well waters are used in making the vinegar, it will be necessary to test separately for the combined and free sulphuric acid. Indeed, it is safest to do this whenever rigid accuracy is required.

The combined sulphates present in vinegars are derived partly from the grain and partly from the water employed. Whether the acid be free or combined may be ascertained in the following manner. If the liquid remains acid after the removal of the acetic acid by distillation, the acidity is most probably due to free sulphuric acid, the amount of which must be ascertained thus: —

A given quantity of the vinegar is first precipitated with chloride of barium, in order to get the total quantity of sulphuric acid present.

A similar quantity is evaporated to dryness, incinerated, and the white ash, after treatment with a few drops of nitric acid, tested for sulphuric acid. If the acid is in the combined state, there will be no difference in the proportions obtained in the two cases.

Further, the quantity of acid contained in the vinegar before and after distillation may be determined; and if the results agree, we obtain additional evidence of the absence of free sulphuric acid.

Another way is to evaporate the vinegar to the consistence of a syrup, and to separate the free sulphuric acid by means of alcohol, and then to proceed to determine its amount in the usual way.

On the Detection of Chillies and other Acrid Substances in Vinegar.— The presence of acrid substances in vinegar may be readily detected. A portion of the vinegar should be evaporated nearly to dryness, and the extract tasted, when the presence of any pungent substance will be plainly revealed to the taste.

On the Detection of Burnt Sugar.— Two or three hundred grains of the vinegar are to be evaporated on a water bath to dryness, the extract boiled with alcohol, the alcoholic solution evaporated, and the residue tasted; if it be of a very dark colour, and of a bitter taste, burnt sugar is no doubt present.

On the Detection of Acetic and Pyroligneous Acids. — It is scarcely possible to detect the presence of acetic acid, since this acid is the chief constituent of all genuine vinegar; but pyroligneous acid may be discovered. Pyroligneous acid, as its name implies, is formed by the destructive distillation of wood; and it usually possesses a smell and taste indicative of its origin and dependent upon the presence of certain impurities, as creosote, &c.* For the detection of this acid, nothing more is necessary than to distil the acid from a portion of the vinegar, to concentrate this by redistillation, and finally to judge of it by the taste and odour.

Of certain alleged adulterations of vinegar, as those with nitric, hydrochloric, and tartaric acids, it is unnecessary to treat, since we are unacquainted with any instance of the use of those acids in the adulteration of vinegar, although it is quite possible that they have been and may still be used in rare instances.

On the Detection of Bitartrate of Potash in Vinegar.—Bitartrate of potash is a constituent of wine vinegar, and as we are often called upon to give our opinion as to whether certain vinegars are wine or malt vinegars, it is necessary that we should be acquainted with the method of detecting that salt. For instructions the reader is referred to the article on Wine.

It should be known that the presence of bitartrate of potash in vinegar affords no certain proof of its being genuine, since this salt may be purposely added. In this case, we must judge by the specific gravity and the aroma of the vinegar, especially when heated, as well as by the character and composition of the extract.

On the Detection of Metallic Impurities in Vinegar.—Ten ounces of vinegar should be evaporated to dryness in a porcelain capsule, and the residue reduced to a white ash; if the ash be brown or rust-coloured, in place of white, it contains iron. The ash should be treated with a few drops of pure nitric acid, distilled water being added after the lapse of a few hours; the solution should be filtered, and a portion of it tested with sulphuretted hydrogen. If it turn black, the vinegar most probably is contaminated with lead; if dark brown, with copper; and if yellow, with tin. If there be no change of colour, it may be concluded that no metallic substance is present. It is proper, however, not to rely for the determination of the metal present upon the colour of the liquid, but to test for that, the presence of which is suspected, by the appropriate reagents.

The following evidence before the Committee on Adulteration by Mr. George Phillips, will show how the Excise protected the revenue from loss resulting from the adulteration of this article at the time a duty was levied upon it:—

Mr. Moffatt. "When there was a duty on vinegar, was it much adulterated?"—"The law allowed a small per-centage of sulphuric acid. I am not aware that it was adulterated beyond that."

Again, by a return of the articles examined for the last twelve years, it appears that the Excise, with its 70 chemists and 4000 inspectors, examined only one sample of vinegar during that long period.

Now vinegar, again, is an article which is constantly adulterated in a variety of ways. So much for the efficiency of the Excise.

The duty on foreign vinegar, which was 4½*d.* per gallon during the war, is now again, by the Act of 19 & 20 Victoria, cap. 75., 3*d.* per gallon (29th July, 1856).

Imports, in 1854, 46,560 galls.; in 1855, 24,105 galls. Home consumption, in 1854, 39,564 galls.; in 1855, 18,982 galls.

PICKLES, AND THEIR ADULTERATIONS.

To persons unacquainted with the subject, the title of this report "Pickles and their Adulterations," may appear somewhat singular; and they may be disposed to ask — Are not the ghirkins, cabbages, beans, &c., which we see in the bottles, what they appear to be? And are other vegetables than those commonly known to us mixed with the ordinary kinds? To these questions we thus reply: — "Ghirkins," on close examination, often turn out to be but shrivelled or sliced cucumbers; the "young tender beans" to be old and tough; the "cauliflowers" to have run to seed; and the "red cabbage" to be nothing more than white cabbage turned into red by colouring matter, as a dyer would change the colour of a dress; further, that amongst the vegetables not unfrequently employed for the purpose of pickle-making are some which do not enter into the calculation of the epicure, as vegetable marrows, — which, when cut into pieces, form a very respectable imitation of cucumbers, — and sliced turnips, the identification of which would be apt to puzzle even a botanist as well as certainly all those who are uninitiated in the secrets of a pickle-manufactory.

But the adulterations to which we more especially allude, and to the consideration of which our attention will be particularly directed in the following remarks, are those which refer to the quality and composition of the vinegar used for pickling, as well as to the means employed for preserving and heightening the colour of green pickles.

In Accum's celebrated work, "Death in the Pot," under the head Poisonous Pickles, we obtain the following information in relation to the "greening" of pickles: —

"Vegetable substances preserved in the state called pickles by means of the antiseptic power of vinegar, whose sale frequently depends greatly upon a fine, lively green colour, and the consumption of which, by seafaring people in particular, is prodigious, are sometimes intentionally coloured by means of copper. Ghirkins, French beans, samphires, the green pods of capsicum, and many other pickled vegetable substances, oftener than is perhaps expected, are met with impregnated with this metal. Numerous fatal consequences are known to have ensued from the use of these stimulants to the palate, to which the fresh and pleasing hue has been imparted according to the deadly *formulæ* laid down in some modern cookery books; such as boiling the pickle with halfpence, or suffering them to stand for a considerable period in brazen vessels."

Dr. Percival ("Medical Transactions," vol. iv. p. 80.) has given an account of "a young lady who amused herself while her hair was dressing with eating samphire pickles impregnated with copper. She soon complained of pain in the stomach; and in five days vomiting commenced, which was incessant for two days. After this her stomach became prodigiously distended, and in nine days after eating the pickles death relieved her from her suffering."

Among many recipes which modern authors of cookery books have given for imparting a green colour to pickles, the following are particularly deserving of censure; and it is to be hoped that they will be suppressed in future editions of the works from which they are extracted:—

"*To Pickle Ghirkins.*—Boil the vinegar in a bell-metal or copper pot; pour it boiling hot on your cucumbers.

"*To make Greening.*—Take a bit of verdigris the bigness of hazel-nut, finely powdered, half a pint of distilled vinegar, and a bit alum powder, with a little bay salt. Put all in a bottle, shake it, and let it stand till clear. Put a small teaspoonful into codlings, or whatever you wish to green."

Mr. E. Raffeld directs: "To render pickles green, boil them with halfpence, or allow them to stand for twenty-four hours in copper or brass pans."

"To detect the presence of copper, it is only necessary to mince the pickles, and to pour liquid ammonia, diluted with an equal bulk of water, over them in a stopped vial: if the pickles contain the minutest quantity of copper, the ammonia assumes a blue colour."

The above remarks and quotations convey a somewhat fearful picture of the colouring of pickles. It will be our object to ascertain how far the statements made apply to their present condition.

Results of Analyses of Samples.

Twenty-three samples of pickles of different descriptions, including mixed pickles, India pickles, ghirkins, beans, Chilies, &c., were subjected to a rigorous chemical examination, with the following results:—

1st. That the vinegar used for pickling is of *a very weak description*, the per-centage of acetic acid ranging between 1·48 and 2·91. It will be remembered, that in our last Report we stated that *vinegar of good quality ought to contain from four to five per cent. of pure acetic acid.*

2nd. That *nineteen* out of twenty *of the vinegars* submitted to analysis, poor as they were, *yet owed a portion of their acidity to sulphuric acid*, the amount of which varied in the different samples from ·38 to 2·52 in the 1000 grains; *the largest quantity of this acid being detected in the vinegars in which the red cabbages were pickled.*

3rd. That *in the whole of the sixteen different pickles analysed for* *copper*, THAT POISONOUS METAL *was discovered in various amounts; two of the samples contained a small quantity; eight, rather much; one, a considerable quantity; three, a very considerable quantity; in one, copper was present in highly deleterious amount; and in two, in poisonous amounts.*

4th. That *the pickles which contained the largest quantity of copper, were those which consisted entirely of green vegetables, as ghirkins and beans.*

Notwithstanding the statements made in books, some of which we have noticed at the commencement of this Report, when we entered upon these inquiries, we felt convinced that so poisonous a metal as copper was now rarely, if ever, employed for the mere purpose of heightening and preserving the colour of green pickles; we are therefore both surprised and grieved at the really fearful character of the results to which our investigations have conducted us. We trust, however, now that conclusive evidence of this scandalous practice has been adduced, and that the public are put up on their guard, a remedy will be found for this great evil.

Pickles, doubtless, when properly prepared, are not very digestible; but we now see that much of the ill effects so generally attributed to their use, must result from their impregnation with so poisonous a contamination as copper.

In some cases *the copper*, usually *the sulphate*, commonly known as *blue stone*, is added direct to the vinegar in which the pickles are preserved; more frequently, however, no direct addition of copper is made, but a sufficient quantity of that metal, in the form of *an acetate*, is obtained by the repeated boiling of the vinegar in copper vessels, but since vinegar is so commonly adulterated with sulphuric acid, a *sulphate of copper* is generally formed as well. Thus it amounts to precisely the same thing whether the copper is added direct to the pickles, or whether it is taken from off the copper utensils employed, by the action of the acids of the vinegar.

One of the worst features of this abominable practice is, that the employment of copper is wholly unnecessary, as the colour of green vegetables may be very well preserved by other means, as by the use of pure vinegar, and the addition of a proper quantity of salt.

Since then, as we have now proved, pickles are so constantly contaminated, and even rendered poisonous, by copper, the only safety for the public is, that all housekeepers should take the matter into their own hands, and become themselves the makers of their pickles.

It is in the vinegar employed for pickle-making especially that we should expect to find acetic and pyroligneous acids; the latter acid is usually detectable by the slight odour of creosote, from which it is almost impossible to free it. It is of importance that the effect of the action of the sulphuric acid contained in many of the pickling vinegars on the colour of the pickles should be determined. Our own impression is, that it would be found to be injurious.

A visit to a large pickle warehouse, such as that of Messrs. Crosse and Blackwell, during the season of pickle and preserve making, is not without interest. The vast piles of vegetables and fruit ready to be sorted, cut, boiled, &c., is really astonishing.

It appears, however, that pickle-making is, to a great extent, independent of the seasons, and that most of the different kinds of pickles may be made at any period of the year. This the makers are enabled to do by keeping a large stock of the various sorts of vegetables immersed in brine and packed in barrels. In some of our largest establishments many hundred barrels thus filled may be seen. We are informed that the greater part of these vegetables come from abroad: it is alleged that they are kept in brine for the sake of economy, and that they would keep far better in vinegar.

On the Detection of the Adulterations of Pickles.

Pickling vinegar is of course liable to the same adulterations as other vinegar. The processes employed for the detection of all the more usual adulterations of vinegar have already been described, and it is not necessary to repeat them in this place; we have then merely to point out the methods by which the presence of copper in pickles is to be determined.

The presence of copper in pickles, bottled fruits and vegetables, and preserves, is often unmistakably indicated by their *colour*.

When the housekeeper preserves these articles, they are usually of a yellow colour rather than green, but as exhibited in shop windows, or purchased of manufacturers of these articles, they ordinarily present a vivid bluish-green colour, more intense than that of the fresh vegetables or fruit. Whenever these articles are of a decided green, they will almost always be found to contain copper; but when they are yellowish or brownish-green, copper is never present.

The copper is found usually both in the pickles and in the vinegar; and for its detection the following processes may be adopted:—

For its detection in pickling vinegar, an ounce or so of the vinegar should be poured into a test glass, and in this a piece of thick iron wire, having a smooth and polished surface, should be immersed for a few hours. If copper be present it will become deposited upon the wire, forming a coating more or less complete and thick, according to the quantity of copper present.

This test may be so readily applied that we recommend the public to make use of it, and so ascertain for themselves whether the pickles they are using contain the poison or not. If only a very small quantity of copper be present it will be quickly deposited on the surface of the iron.

We have ourselves tried this simple proceeding, first with half an ounce of two vinegars in which the pickles were contained, in which much copper was present; in each case, after the lapse of three or four hours, a well-marked coating of copper had formed upon the iron rod. We next tried it with two vinegars previously ascertained to contain the smallest quantity of copper; in these cases also, after the lapse of a few hours, an incrustation of copper was formed.

Another very simple and efficient method is the following:—

Put three or four drops of the suspected vinegar on the blade of a knife; add one drop of sulphuric acid, and heat the under surface of the knife over the flame of a candle; the vinegar, in evaporating, will deposit the copper upon the iron, if any be present.

For the detection of copper in the pickles themselves, the annexed process may be adopted.

About 1000 grs. of the green vegetables of each of the pickles, after having been sliced with a glass knife, are to be incinerated, care being taken to avoid every source of contamination: the ash, having been pulverised, is to be treated with 20 drops of pure nitric acid; 1 oz. of distilled water, after the lapse of a short time, added, the solution filtered, and treated with excess of ammonia. If copper is present, the solution becomes more or less blue, according to the amount of the metal present.

For the *quantitative estimation of copper* in pickles, we must proceed as follows:—

3000 or 4000 grs. of the pickles, including a fair proportion of the vinegar, must be evaporated to dryness, then incinerated; the ash treated with about two drachms of nitric acid diluted with an equal quantity of water; the whole boiled for a few minutes, evaporated to dryness, the residue diluted with one ounce more water, boiled again for a time, the solution filtered, and the copper precipitated by means of sulphuret of ammonium; the sulphuret of copper must be collected, dried, weighed, and the copper determined.

Import duty, preserved in vinegar, 1*d.* per gallon; preserved in salt, free.

Imports, preserved in vinegar, in 1854, 5328 galls.; in 1855, 3998 galls. Home consumption, in 1854, 4904 galls; in 1855, 3278 galls.

ON POISONOUS BOTTLED FRUITS AND VEGETABLES.

An attentive examination, with the eye alone, of various samples of bottled fruits and vegetables, served to raise suspicion, and to produce the impression that the method of preservation adopted by modern preservers of these articles was not quite so harmless as that originally proposed by Mr. Saddington. We felt, indeed, a strong conviction that the same means of coloration was resorted to in the case of bottled fruits and vegetables as we had already ascertained to be employed with pickles. In order to determine whether this conviction was well founded or not, we resolved to institute a series of rigorous analyses, the results of which we are now about to make known.

The extraordinary effect of copper, in heightening and rendering permanent the green colour of fruits and vegetables, has already been remarked upon in the report on Pickles. This action is exerted upon the green contents of the cells, the chlorophylle, and hence it is the coloured portions of vegetables and fruits, as those invested by the epidermis, which are most affected by this substance. The copper used accumulates in this membrane as a salt—as an acetate, a citrate, or a malate of copper.

The presence of copper, however, in fruits and vegetables is not confined to the coloured portions; it penetrates through the whole tissue; and a considerable part of the metal used even remains diffused throughout the fluid in which the vegetable substance is contained: hence it is desirable to analyse for copper not only the preserved article itself, but also the fluid in which it is immersed.

Results of Analyses of Samples.

Thirty-four samples of different kinds of bottled fruits and vegetables were therefore subjected to chemical analysis. From this analysis the following conclusions were deduced:—

1st. That of the *thirty-three* samples of preserved fruits and vegetables *seven were free from contamination with copper.*

2nd. That *twenty-seven* samples *were more or less impregnated with that metal.*

3rd. That *traces of copper were discovered* in *three* of the samples.

4th. That in *seven* of the samples *copper was present in small amount only.*

5th. That *eight* samples contained it *in considerable amount.*

6th. That in *six* samples the metal *was present in very considerable amount.*

7th. That *four* of the samples contained this poisonous impregnation *in very large quantities.*

8th. That the samples of *limes contained copper*, the one in *small amount* only, the other in *amount more considerable.*

9th. That *gooseberries*, as commonly preserved, contain *a considerable amount of copper*, and *some samples even a very large quantity.*

10th. That *rhubarb* usually contains an amount of copper *more* *considerable, some samples being contaminated with it to a very large extent.*

11th. That *greengages* in general contain *a still greater quantity of copper*, the metal being frequently present *in highly dangerous amounts.*

12th. That in *olives* this *poisonous impregnation is in the largest amount*, although its effect in heightening the colour of the fruit is less marked than in the other cases.

13th. That the preserved *red fruits*, as currants, raspberries, and cherries, are *not as a rule contaminated with copper.*

The absence of copper in red fruits, and the variation of the quantity of that metal in green fruits according to the requirements in each case, afford clear evidence that this dangerous impregnation does not arise from the mere use of copper utensils, but that it is purposely introduced, the quantity being systematically adjusted in different proportions, determined by the kind of fruit preserved.

That this conclusion is correct is conclusively shown in another way. According to the method of preparation usually pursued, the fruit or vegetable is not supposed to come in contact with copper.

The fruit or vegetable is taken directly from the baskets or sieves in which it is received from the country, and carefully packed in bottles; these are next filled up with a liquid, consisting of water holding a small quantity of alum in solution; they are then loosely corked, and submitted for a certain time to the heat of a water-bath, so as to ensure the coagulation of the vegetable albumen; they are afterwards more tightly corked, tied over with string or wire, and further secured with resin and bladder, or with a metallic capsule.

The presence of copper, then, in bottled fruits and vegetables can only be explained on the supposition that it is purposely introduced; and this is really the case.

As in the case of bottled fruits and vegetables there is no vinegar to act upon the copper of the vessels, the copper, usually *the sulphate or blue stone*, is in all cases added direct to these articles. We have the authority of a manufacturer for stating that the quantity of this powerful and almost poisonous substance used is often fully as much as sixty grains to one gross of bottles of the fruit; this gives not far short of half a grain per bottle, which is a full medicinal dose.

In some cases, where the quantity of copper is considerable, the metal becomes deposited on any metallic surface it may happen to come in contact with, in the course of a few minutes. In proof of this we will quote a paragraph from a letter written by Mr. Bernays, a chemist resident in Derby, addressed to the "The Lancet." He writes,—

"I had bought a bottle of preserved gooseberries from one of the most respectable grocers in this town, and had had its contents transferred into a pie. It struck me that the gooseberries looked fearfully green when cooked; and on eating one with a steel fork, its intense bitternesss sent me in search of the sugar. After having sweetened and mashed the gooseberries with the same steel fork, I was about to convey some to my mouth, when I observed the prongs to be completely coated with a thin film of bright metallic copper. My testimony can be borne out by the evidence of three others, two of whom dined at my table."

In the preservation of red fruits, no copper is used; but here, again, we are informed, that red colouring matter, as decoction of logwood, or infusion of beet root, is not unfrequently employed, especially where the fruit is damaged or of inferior quality.

The colour of green fruits and vegetables is sometimes apparently heightened by a second device; the bottles in which they are enclosed are made of a highly coloured glass; those in which French olives are preserved are of so intense a green as to impart to the fruit as seen through the bottles a deep-green colour.

As a rule, the amount of copper ordinarily present in many kinds of bottled fruits and vegetables is greater for even equal quantities than in pickles, which, as we have shown, also frequently contain that metal in large and almost poisonous quantity. Add to this the fact that while pickles are used in small quantity only, a whole bottle of preserved fruit is consumed by two or three persons at one time; hence we perceive how much more dangerous is the employment of copper in the case of fruits than in that of pickles.

The present adds another instance to the many which have already been adduced, in which manufacturers, in order to heighten the colour of articles, and as they conceive, often very erroneously, to improve their appearance, have sacrificed their flavour and quality, and have risked health, and even safety.

On the Detection of the Adulterations of Bottled Fruits and Vegetables.

The chief adulterations of these articles are those *with salts of copper*, added for the purpose of heightening their colour. In many cases the intense green or bluish-grey colour, greatly increased when the fruit or vegetable is cooked, is sufficient to betray the presence of copper, especially to an accustomed eye.

For the detection of copper by chemical means we must have recourse to the processes described under the head of Pickles.

The copper is found, as in the case of pickles, in the preserving fluid as well as in the fruit or vegetable itself.

If we desire to test the liquid, we proceed as follows:—

About three ounces of the juice or fluid in which the fruit or vegetable is preserved are to be measured out, and placed in a test glass; the acidity is to be slightly increased by the addition of about three drops of strong nitric acid, and a polished rod of iron placed in the fluid, and allowed to remain for about twenty-four hours. If copper is present in considerable amount, the surface of the rod, from top to bottom, becomes covered with a continuous and bright coating of that metal. If the amount of copper is less considerable, the upper half or so only of the rod receives the coating. If the quantity is very small indeed, no perceptible deposit of copper will take place.

Hence we perceive that the iron rod affords a simple and most conclusive test for copper in fruits and vegetables, when present in anything like considerable amount, and that it even serves to indicate, to a certain extent, the quantity of copper with which the juice of different samples is impregnated, as shown by the rapidity with which the deposit occurs, by the thickness of the coating, and by the extent of surface covered by it.

If we desire to analyse the fruit or vegetable, we must proceed as follows:—Three ounces of each of the fruits and vegetables are to be weighed out, placed in crucibles, and incinerated until nearly the whole of the carbon is dissipated, the colour of the ash being carefully noted. In those cases in which the fruit or vegetable is not contaminated with copper, the residual ash is observed to be either white or greyish-white, while in those instances in which copper is present it is constantly of a pink colour; the depth varies uniformly with the amount of copper present.

We have already adverted to the pink colour of the ash of vegetable substances containing copper, as affording an excellent test of the presence of that metal. In the case of bottled fruits and vegetables this is a peculiarly delicate test.

When fruits or vegetable substances are carefully incinerated without being in any way disturbed, the general form of the fruit, &c., is in most cases tolerably well preserved; and it is then perceived that the pink colour is confined principally to the surface of the substance incinerated.

In those cases in which the amount of copper is but very small, the pink will be seen on the surface, only here and there, and will be of a pale tint. Where the quantity is larger, although still but small, the colour will be more general and more decided. Where it is abundant, the whole surface of the ash will be of a bright and beautiful rosy-pink hue. Lastly, when the quantity of copper present is very considerable, the residual ash will be of a deep pink colour.

Olives, when incinerated, do not leave a clean white ash, so that although the colour may be very well detected in them, it is not of so bright a pink as in other fruit; and the colour is not confined, as in most other cases, to the surface of the fruit, but extends through its whole substance.

When a portion of the juice is incinerated along with the fruit, as is usually the case, the crucibles, if copper is present, become tinted with the same rosy-pink colour observed on the surface of the fruit or vegetable incinerated. In some cases where the amount of copper is considerable, the bottoms of the crucibles become deeply and beautifully stained of a bright and iridescent pink.

The pink colour of the ash is thus explained. In the course of incineration the acid with which the copper was combined is destroyed, the highly characteristic pink oxide alone remaining in the fruit, and its presence being revealed by its peculiar colour.

We have, then, in the colour of the ash a certain and beautiful test of the presence of copper, even in the most minute quantities, and likewise for the determination of its amount to a certain extent, not not only in bottled fruits, but in most vegetable substances, and especially in pickles.

The tint of the ash having been noted, it may next be treated in the same manner as the ash of pickles.

When copper is present, the colour of the acidulated solution of the ash, when ammonia is added, varies greatly, from a pale and scarcely perceptible bluish hue to a rich and deep azure, according to the quantity of the metal present.

As a further test, the metal may be separated from the ammoniacal solution in the following manner:—

Acidulate the solution, and immerse in it a piece of polished iron wire, when the copper will become deposited upon it. A coating of copper may often be obtained from the acidulated solution of the ash in cases where no deposit of metal takes place on immersion of the iron in the juice in which the fruit or vegetable was preserved.

ON THE CONTAMINATIONS AND ADULTERATIONS OF PRESERVES AND JELLIES.

We have repeatedly shown that the adulterators of our food do not scruple to employ, when it suits their purpose, the most deadly substances, undeterred by the serious consequences which but too frequently result from their use. Thus, it has been shown that it is no uncommon thing for them to make use of various preparations of iron, lead, copper, arsenic, mercury, &c. It is not a little remarkable, that the majority of the substances are had recourse to, not on account of bulk or weight, but for the mere sake of colours, which, thus procured, are frequently in a high degree glaring and unnatural, these colours being obtained, too, at the expense of quality and flavour.

Amongst the articles which have already been treated of, and in which foreign colouring ingredients have been detected, are tea, chicory, cocoa, Cayenne, mustard, pickles, bottled fruits and vegetables, potted meats and fish. The list is, however, far from complete as yet; and on the present occasion we have to add to it other articles.

Preserves and jellies prepared in copper vessels are always contaminated to a greater or less extent with *copper.*

But in the case of green preserves, as in those of pickles, bottled fruits and vegetables, copper is used intentionally for the purpose of increasing the colour.

Again, in some cases the preserves and jellies are actually adulterated.

Vegetable jellies consist of the thick and transparent part of the fruit only, the husks and seeds being removed. Now, these really worthless portions of the fruit are rarely, if ever, thrown away by the manufacturers of preserves; but, mixed with a little fresh fruit, they are passed off as good jams. In this practice housekeepers are furnished with a strong reason for preparing their own preserves, and also with an explanation of the general superiority of home made preserves.

A similar use is said to be sometimes made of the refuse parts of fruits used in the manufacture of home-made wines.

Orange Marmalade, which when genuine consists only of the bitter or Seville orange, is frequently adulterated with sweet oranges, with apples and turnips. We have been informed that a species of swede of a yellow colour is much used in the adulteration of orange marmalade.

Lastly, we have good authority for stating that partly-decayed oranges, and even sucked oranges, are used in the adulteration of this favourite preserve; these statements rest upon the authority of an eye witness.

Raspberry jelly is usually nothing more than currant jelly, to which the flavour of the raspberry has been communicated by means of orris root.

The *raspberry flavouring* for sugar confectionary is made entirely of currant jelly and orris root.

Lastly, the jellies in bottles and those sold by confectioners, as isinglass and calf's foot jelly, consist principally of *gelatine* variously *coloured.*

Results of Analyses of Samples.

Thirty-five samples of preserves and jellies of various kinds were subjected to microscopical and chemical examination and with the following results:—

1st. That the *Raspberry Jam* analysed contained a very considerable quantity of *copper.*

2nd. That the four samples of *Gooseberry Jam* examined all contained *copper.*

3rd. That copper, sometimes in large amount, was detected in twelve of the fourteen samples of *Orange Marmalade* analysed.

4th. That three of the *Marmalades* were adulterated with large quantities of *a vegetable substance,* most probably either *turnip* or *apple.* There is a kind of turnip, the seeds of which are frequently advertised in the "Gardener's Chronicle" for sale, of a yellow colour, and which is called the orange turnip. We know not to what use this can be put unless in the adulteration of orange marmalade.

5th. That the nine samples of *Greengage Jam* were all more or less impregnated with *copper*, it being present in considerable amount in five of the samples.

6th. That the *Greengages* contained in three different boxes of *Crystallised Fruits* all owed their deep-green colour to the presence of *copper.*

7th. That the *Limes* and *Greengages* present in a little glass jar of fruit preserved in jelly also owed their brilliant colour to a salt of *copper.*

8th. That *copper* was present in the three samples of *Candied Citron Peel* subjected to analysis.

9th. That *copper* was detected in no less than *thirty-three* of the *thirty-five* samples of different preserves analysed: three contained *traces* only; in *eleven* the metal was present *in small quantity;* and in nineteen either *in considerable* or even *very large amount.*

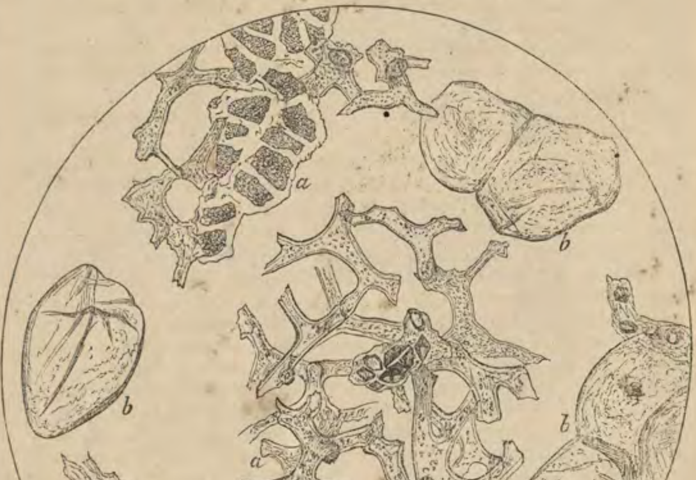
Knowing well the powerful action of vegetable juices, and also of sugar, upon copper, we have long entertained the belief that that metal would be very frequently detected, on analysis, in preserves, jams, and jellies, as ordinarily prepared: we must acknowledge, however, that the result of actual investigation has far exceeded our expectations, since it has proved that preserves made in copper vessels not only almost invariably contain copper, but that the metal is often present in very considerable quantities, sufficient to tint the ash of a deep pink, and to cause the solution of the ash when treated with ammonia to become of a decided and sometimes even of a deep blue colour.

But the still larger quantities of copper detected in certain of the samples of greengage jam seem to show that, as was ascertained to be the case with bottled fruits and vegetables, some greening salt of copper, the sulphate or acetate, is really intentionally introduced for the purpose of creating an artificial viridity.

It will be perceived, also, that three of the samples of orange marmalade examined were adulterated with large quantities of a vegetable substance, resembling in its microscopic structure either *turnip* or *apple.* These samples were all purchased in the beginning of December. Many other samples purchased in the summer, and also several procured within the last few days, were all entirely free from any such admixture. This appears to prove that this adulteration is practised chiefly at a certain period of the year, when oranges become scarce, and in order to keep up the stock of marmalade, so called. The detection of this adulteration in three samples, two of them obtained at the establishments of different makers, appears also to show that the adulteration is a very general one.

The disclosures now made afford convincing proof how improper and even dangerous it is to make preserves, as is commonly done even by ordinary housekeepers, in copper saucepans. The vessels employed for this purpose should consist of earthenware, or, if metallic, should be lined with enamel.

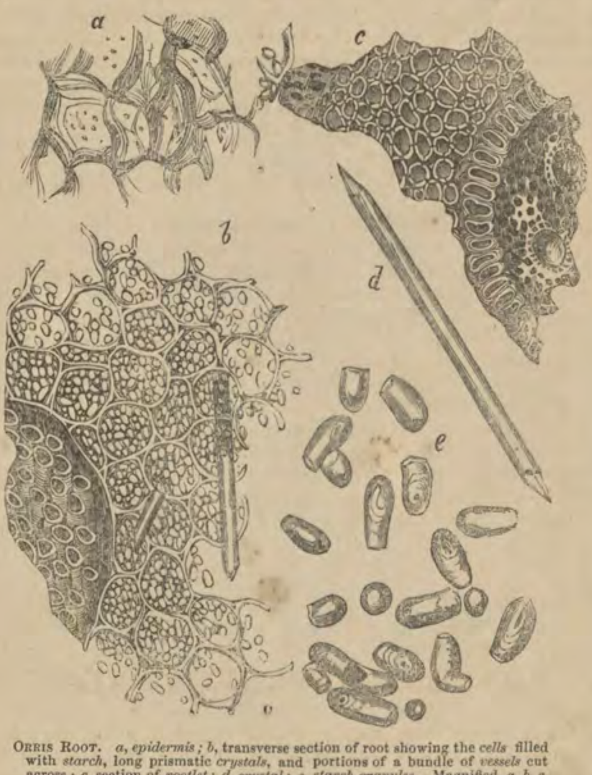
Fig. 153.



Orange Marmalade, adulterated with *Apple* or *Turnip*. *a a*, tissue of orange; *b b*, cells of foreign vegetable substance. Magnified 100 diameters.

Although we may fairly expect to find copper in any preserved vegetable substance prepared in the ordinary manner, yet we scarcely expected to meet with that poison in those tasteful and sparkling little boxes of bonbons which at Christmas time are spread out in shop windows so attractively; neither did we expect to find it making its way, through the citron-peel used, into our very Christmas plum-pudding.

Fig. 154.



ORRIS ROOT. *a, epidermis*; *b*, transverse section of root showing the *cells* filled with *starch*, long prismatic *crystals*, and portions of a bundle of *vessels* cut across: *c*, section of *rootlet*; *d, crystal*; *e, starch granules*. Magnified, *a, b, c,* 100, *d* 200, *e* 500 diameters.

The evils and dangers arising out of the all-prevalent and very scandalous practice of adulteration, nothing but the strong arm of the law can sufficiently check; and the force of this, ere long, no doubt, will be felt. Nevertheless we are happy to find that great and immediate good very frequently results from the exposures which from time to time we are compelled to make; this is very evident in the case of pickles, and preserved fruits and vegetables. Although we still see in shop windows hundreds of bottles of these articles exposed, highly charged with copper, yet it must be allowed that a very great improvement has taken place in this respect since the period of our first report on Pickles. We have reason to believe that one very large manufacturing firm, which supplies some hundreds of retail establishments, both in town and country, has to a very great extent, if not entirely, abandoned the use of copper. and copper utensils, in the greening of their pickles and preserves. Such an example cannot but have an excellent effect on other manufacturers and preparers of similar articles.

On the Detection of the Adulterations of Preserves and Jellies.

The adulteration of one kind of preserve by the addition of another cheaper kind, can in most cases be discovered by means of the microscope. The structure of the strawberry, raspberry, and currant, especially of their seeds, is very different. By means of the same instrument, vegetable jellies may sometimes be distinguished one from the other, by the remains of the different tissues discoverable in them.

The adulteration of orange marmalade with apple or turnip is likewise readily discoverable by the aid of the microscope. *Fig.* 153.

Lastly, the presence of orris root in any jelly, as well as in snuff, may be detected by the same means, as will at once be perceived on an examination of the annexed figure. *Fig.* 154.

The methods employed for the determination of the presence of copper in preserves and jellies are the same as in the case of pickles and bottled fruits, to the articles on which the reader is referred.

SAUCES, AND THEIR ADULTERATIONS.

A GREAT variety of substances, chiefly vegetable, enter into the composition of the various sauces in use. The following is an enumeration of the chief of these: — Tomato, garlic, shallot, sorrel, mushroom and walnut catsup, raisins, tamarinds, the seeds of fenugreek and cumin, the leaves of a variety of herbs, as taragon, chervil, mint, thyme, marjoram, &c., the seeds of an Indian plant called *Dolichos soja* or *soya*, of which soy is made; a variety of spices and condiments, as pepper, Cayenne, mustard, mace, cloves, ginger, and nearly all the other spices; salt, treacle, and burnt sugar as colouring agents, and flour as a thickening ingredient. Out of the above articles, variously combined, and in different proportions, nearly all the sauces in use are compounded. Into the composition of some few, however, animal substances enter, as the muscular fibre of shrimps, lobster, and anchovy.

The following are the chief results deducible from a consideration of the analyses of *Thirty-three* samples of sauce of different kinds: —

1st. That *treacle* and much *salt* formed the basis of the five samples of INDIA SOY examined, if they did not even entirely consists of these two ingredients.

2nd. That of the seven samples of TOMATO SAUCE analysed, six were artificially coloured, one probably with *cochineal*, and the rest by the addition of considerable quantities of the ferruginous pigment *bole Armenian.*

3rd. That the samples of ESSENCE OF LOBSTERS examined were almost saturated with very large quantities of *bole Armenian.*

4th. That the samples of ESSENCE OF SHRIMPS were saturated to an equal extent with *bole Armenian.*

5th. That the whole of the samples of ESSENCE OF ANCHOVIES analysed were adulterated with immense quantities of the ferruginous oxide *bole Armenian.*

6th. That three of the samples of *Essence of Anchovy* contained but a small quantity of *muscular fibre.*

7th. That two of the samples contained a portion of *flour* — one being a sample of essence of shrimps, and the other of essence of lobster.

8th. That out of the eighteen RED sauces submitted to examination, no less than sixteen contained *bole Armenian,* and this usually in immense quantities, far exceeding what was detected in any of the potted meats and fish.

9th. That LEAD, for which separate analyses were made in each case, was *not detected in a single instance.*

10th. That *traces only of* COPPER *were discovered in some three or four samples.*

The above results, then, regarded as a whole, although bad enough, are yet not so bad or serious as the account given by Accum and some other writers, of the adulteration of anchovy paste, &c., would lead us to infer, since lead was not detected in a single instance. There is no doubt, however, but that lead does sometimes occur. Mitchell states, "several samples which we have examined of this fish sauce, 'poisonous anchovy sauce' have been found contaminated with lead."

Further, it is more than probable that the muscular fibres in several of the samples of anchovy, lobster, and shrimp sauces, consisted either entirely or in part of the fibres of other inferior and cheaper fish.

The only effectual remedy against certain of the adulterations of the sauces, especially the fish sauces, consists in their preparation at home. Receipts for several of the sauces are given at page 512. of the author's work, "Food and its Adulterations."

It appears, then, that the red sauces, as those of shrimp, lobster, anchovy, and tomato, are almost invariably highly coloured with bole Armenian. This, as has already been pointed out, is a natural earth, containing a large quantity of the red oxide of iron; but frequently an article is made in imitation of it, consisting of a mixture of Venetian red and chalk. Of this red earth or dirt as much as from 10 to 15 lbs. are added to 100 galls. of anchovy sauce.

Cooks frequently colour the sauces prepared by them for the table with carmine; this when genuine, is a vegetable colour, but it is frequently adulterated with *vermilion.*

Perceiving clearly the evils connected with the employment of artificial colouring matters, Messrs. Crosse and Blackwell have, to a very great extent, abandoned their use, and they now prepare anchovy sauce free from colouring matter. The difference between the ordinary.coloured and the uncoloured sauces is very striking; the first is usually intensely red — as red, in fact, as a brickbat, this redness arising entirely from the introduction of the bole Armenian, — while the other is usually of a pinkish-fawn colour.

The various colouring matters to which reference has already been so frequently made, are used not merely for the sake of increasing the colour of articles, and thus, as it is very often erroneously considered, improving their appearance, but likewise for other purposes, especially to conceal other adulterations; thus, when very large quantities of wheat flour are added to mustard, or flour and sugar to cocoa, the natural colour of those articles becomes so reduced that the addition of some foreign colouring matter is rendered necessary.

Not unfrequently the use of these colouring matters involves considerations of cleanliness; this is so in the case of anchovy sauce. The quantity of refuse matters and dirt contained in the fish from which this is prepared is often very great; and it is the presence of these more than anything else which causes the sauce to present a somewhat unsightly appearance before the red earth is added. It is this circumstance which has chiefly led to the use of the bole Armenian; the maker, in place of carefully removing the refuse and dirt, grinds it all up with the fish, trusting to the bole Armenian to conceal the impurities, thereby saving himself much trouble and some loss. We are informed by Messrs. Crosse and Blackwell, that the impurities which they are obliged to remove in the preparation of the uncoloured anchovy sauce are almost incredible, but that the extra trouble and loss are fully compensated by the greatly improved quality and flavour of the article.

Notwithstanding this improvement in quality, so strong do Messrs.

Crosse and Blackwell find the prejudice in favour of the red sauce, that many parties absolutely refuse to take the uncoloured sauce—preferring the inferior article simply because of its redness.

SPICES, AND THEIR ADULTERATIONS.

We now come to the consideration of the important subject of Spices and their Adulterations.

The spices, of the adulteration of which we are about to treat, are Ginger, Cinnamon, Cassia, Nutmegs, Mace, Cloves, Allspice or Pimento.

When it is remembered that many spices are sold in the state of powder, and most of them bear a high price, and that they are nearly all subject to a duty, which in some cases is considerable, it might be supposed that they would be peculiarly subject to adulteration.

Notwithstanding these facts, little or no attention has hitherto been bestowed upon this subject by writers on the sophistication of food, or even by the Excise authorities, whose duty it should be to protect the revenue from all frauds resulting from the adulteration of duty-paying articles.

GINGER, AND ITS ADULTERATIONS.

The ginger plant, *Zinziber officinale*, belongs to the very useful natural order, *Zinziberaceæ*, from which turmeric, East India arrowroot, and some other productions, are obtained.

Ginger grows and is cultivated in the tropical regions of Asia, America, and Sierra Leone.

The stem reaches generally three or four feet in height, and is renewed yearly; while the root, which is the part known as ginger, botanically termed a *rhizome*, is biennial.

The roots, or rhizomes, are dug up when about a year old; in Jamaica this occurs in January or February, and after the stems are withered. They are well washed, freed from dirt, and in some cases, especially with the better kinds, the epidermis or outer coat is stripped off; and hence the division of ginger into white (scraped or uncoated), and into black (unscraped or coated).

In estimating the quality of ginger, a variety of particulars have to be taken into consideration—as whether the rhizomes are coated or uncoated, their form, colour, and consistence.

The rhizomes of ginger of *good quality* have no epidermis, are plump, of a whitish or faint straw-colour, soft and mealy in texture, with a short fracture, exhibiting a reddish, resinous zone round the circumference; the taste should be hot, biting, but aromatic.

The rhizomes of ginger of *inferior quality* are frequently coated with the epidermis, are less full and plump, often contracted and shrivelled; of darker colour, being of a brownish-yellow; of harder texture, termed *flinty;* and more fibrous; while the taste is inferior, and less aromatic.

Composition of Ginger.

Ginger was analysed by Bucholz* in 1817, and by Morin† in 1823.

BUCHOLZ'S ANALYSIS.

Pale yellow volatile oil	1·56
Aromatic, acrid, soft resin	3·60
Extractive soluble in alcohol	0·65
Acidulous and acrid extractive insoluble in alcohol	10·50
Gum	12·05
Starch, analogous to bassorin	19·75
Apotheme, extracted by potash (ulmin?)	26·00
Bassorin	8·30
Woody fibre	8·00
Water	11·90
	102·31

MORIN'S ANALYSIS.

Volatile oil.
Acrid soft resin.
Resin insoluble in ether and oil.
Gum.
Starch.
Woody fibre.
Vegeto-animal matter.
Osmazoma.
Acetic acid, acetate of potash, sulphur.
The ashes contained carbonate and sulphate of potash, chloride of potassium, phosphate of lime, alumina, silver, and oxides of iron and manganese.

The *volatile oil* is pale yellow, very fluid, lighter than water; odour resembling that of ginger, taste at first mild, afterwards hot and acrid.

Soft resin, obtained by digesting the alcoholic extract of ginger, first in water, then in ether; it possesses an aromatic odour, and a burning aromatic taste. It is readily soluble in alcohol, ether, and turpentine.

Structure of Ginger.

Examined with the microscope, the rhizome of ginger is found to present a well-marked and characteristic structure.

The outer coat or epidermis consists of several layers of large, angular, transparent cells of a brownish colour, adhering firmly together, forming a distinct membrane, and when macerated in water, becoming soft and somewhat gelatinous.

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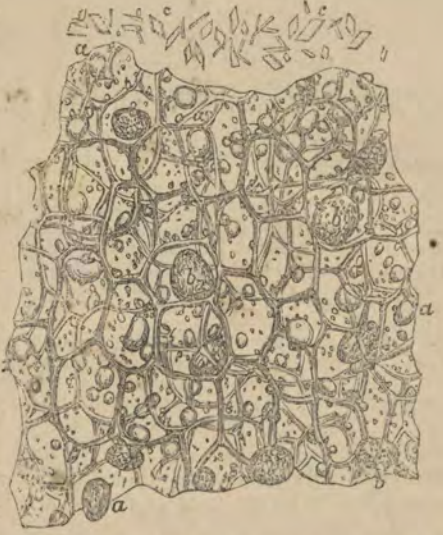
* Brande's Dict. of Materia Medica.

† Gmelin's Handb. d. Chem.

Lying upon the under surface of this membrane, and scattered irregularly over it, are generally to be detected oil globules of various sizes, and of a deep yellow colour, as well as a few cells, identical in structure and tint with those of turmeric.

In the substance of the rhizome itself several structures have to be described.

Fig. 155.



A portion of the *epidermis* of the rhizome of GINGER, showing the cells of which it is composed, as well as the oil globules, *a a*; also the turmeric-like cells, *b b*; and *c c*, crystals very commonly noticed in great numbers lying beneath the epidermis.

It consists principally of cells having delicate transparent walls minutely punctated, and adhering together so as to form a connected tissue. These cells contain in their cavities starch corpuscles, which are very abundant, and many of which, as the cell walls are easily broken, are seen in most sections to have become effused.

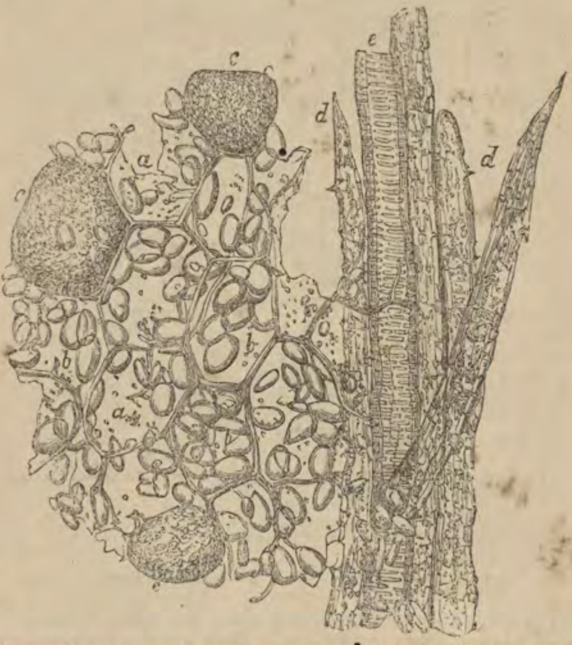
Lying here and there in the midst of the above-described cells, are other cells of nearly similar size and form, but of a bright yellow colour; these are in no respect distinguishable from the coloured cells of turmeric.

It is to the presence of these cells that ginger owes its colour, which varies with the number of such cells contained in it.

Traversing the rhizome in a longitudinal direction are bundles of woody fibre, sometimes inclosing, usually one, but occasionally two or even more dotted ducts or vessels.

The starch corpuscles resemble in some respects those of East India arrowroot, *Curcuma angustifolia*, but are yet characterised by several distinct features.

Fig. 156.



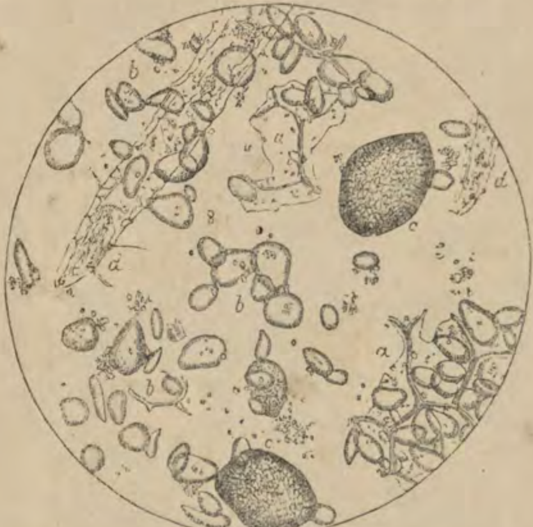
This engraving represents the several tissues observed entering into the formation of the *ginger rhizome*, deprived of its epidermis : *a a*, cells containing the starch corpuscles ; *b b*, starch granules ; *c c*, turmeric-like cells ; *d d*, woody fibre ; *e*, dotted duct.

Although, like those of *C. angustifolia*, they are usually elongated and flattened, they yet differ from the starch granules of that plant in being somewhat smaller, less elongated, and in the greater obscurity of the hilum and curved lamellæ.

The structures above described are shown in the preceding drawing.

In ground ginger the above structures are separated from their proper connection, and occur variously intermixed, and more or less broken and comminuted. See *fig.* 157.

Fig. 157.



Genuine ground ginger: a a, cells which contain the starch corpuscles; *b b*, loose starch granules; *c c*, turmeric-like cells; *d d*, woody fibre.

ON THE ADULTERATIONS OF GINGER.

In order to improve the colour of ginger, and, according to some, to protect it from the attacks of insects, it is frequently rubbed over with lime; in other cases it is washed in chalk and water, when it is called *white-washed ginger;* lastly, the surface of ginger is occasionally bleached by means of a solution of chloride of lime, and sometimes even by exposing it to the fumes of burning sulphur, and is thus made to present a white and floury appearance. By these processes an inferior ginger is often made to assume the appearance of the better descriptions.

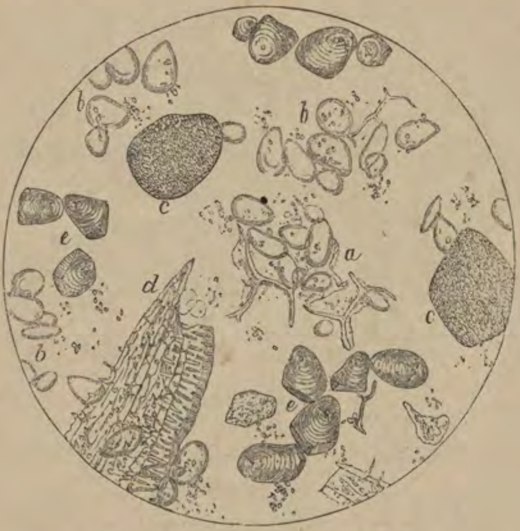
But ginger is frequently adulterated. Out of *Twenty-one* samples of ginger submitted to examination, no less than *fifteen*, being more than two thirds of the whole, were found to be *adulterated.*

The substances detected were various in character, including *sago meal, tapioca, potato flour, wheat flour, ground rice, Cayenne pepper, mus-*

tard husks, and *turmeric powder*,—these occurring in various quantities, but in the majority of cases constituting the principal part of the article.

The Cayenne pepper and mustard husks are no doubt added, with the view of concealing the other adulterations, and of giving apparent strength to the ginger.

Fig. 158.



Powdered GINGER adulterated with *sago powder*.

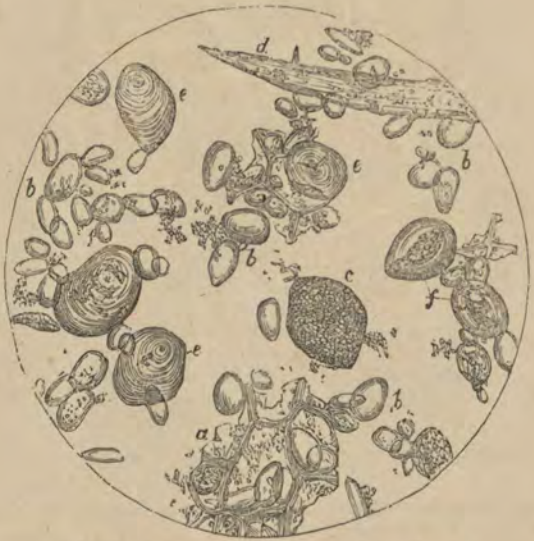
a a, cells of ginger ; *b b*, starch granules of ginger ; *c c*, large yellow corpuscles analogous to those of turmeric ; *d d*, fragment of woody fibre ; *e e*, starch corpuscles of *sago meal*.

On the Detection of the Adulterations of Ginger.

The whole of the substances employed in the adulteration of ginger may be detected with ease and certainty by means of the microscope. The microscopical characters of most of the articles used have already been described : as wheat flour, at p. 243. ; ground rice, at p. 255. ; Cayenne, at p. 376. ; — those of the remaining articles, sago, at p. 325. ; potato flour, at p. 320. ; turmeric, at p. 389. ; and mustard husk, at p. 349.

The structural peculiarities of Cayenne and mustard husk are so well marked, that no difficulty whatever is experienced in identifying them when once seen under the microscope ; but in those cases in which the quantities present are but small they are apt to be overlooked. It is advisable to wash away some of the starch from the portion of powder about to be placed under the microscope; by this means the larger particles are brought more clearly into view.

Fig. 159.



Powdered GINGER adulterated with *potato* and *sago starches.*

a a, cells of ginger; *b b*, starch granules of ginger: *c*, large yellow cell, analogous to those of turmeric; *d*, woody fibre; *e e*, starch granules of *potato; f f*, starch corpuscles of *sago*, altered by heat.

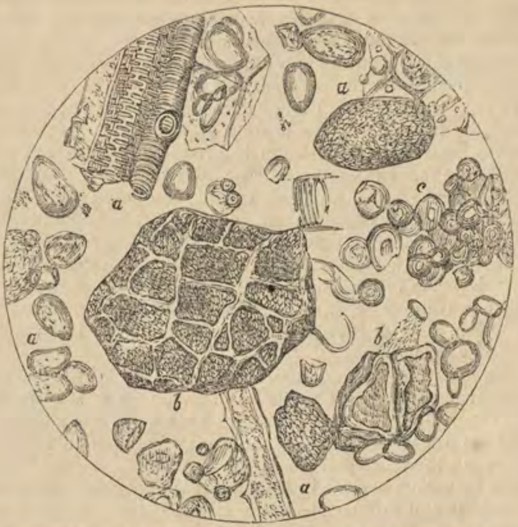
The adulteration with wheat flour is one which might readily escape detection. The observer is therefore cautioned before proceeding to the examination of powdered ginger to compare carefully the structural peculiarities of the starch granules of ginger and wheat flour: the differences, although not at first striking, are really considerable.

Since ginger contains yellow cells very closely resembling those of turmeric, we can only conclude that turmeric has been added when the number of such cells is much greater than in genuine powdered ginger.

The adulterations of ginger with sago and potato are exhibited in the two preceding engravings.

The following engraving represents the adulteration of powdered ginger with tapioca and Cayenne.

Fig. 160.



Powdered GINGER, *a a*; adulterated with *Cayenne*, *b b*; and *tapioca*, *c c*. Magnified 200 diameters.

The duty was *5s.* per cwt. British, and *10s.* foreign possessions; it is now *5s.* of whatever origin. Imports in 1854, 24,803 cwts.; in 1855, 16,503 cwts. Home consumption in 1854, 16,637 cwts.; in 1855, 21,413 cwts.

The duty in 1851 amounted to 7,362*l.* 0*s.* 9*d.* It therefore follows that on this small article the revenue suffers a loss through its adulteration of some thousands of pounds yearly.

CINNAMON, AND ITS ADULTERATIONS.

Cinnamon is the bark of the *Cinnamomum Zeylanicum*, one of the Lauraceæ, or Laurel family, to which also belong Cassia and Camphor, as well as some other plants possessing medicinal properties, especially Clove bark.

Cinnamon is cultivated principally in Ceylon.

"The cinnamon bark of Ceylon is obtained by the cultivation of the plant. The principal *cinnamon gardens* lie in the neighbourhood of Columbo. The bark peelers or *choliahs*, having selected a tree of the best quality, lop off such branches as are three years old, and which appear proper for the purpose. Shoots or branches much less than half an inch, or more than two or three inches in diameter, are not peeled. The peeling is effected by making two opposite (or, when the branch is thick, three or four) longitudinal incisions, and then elevating the bark by introducing the peeling knife between it. When the bark adheres firmly, the separation is promoted by friction with the handle of the knife. In twenty-four hours the epidermis and greenish pulpy matter (rete mucosum) are carefully scraped off. In a few hours the smaller quills are introduced into the larger ones, and in this way a congeries of quills formed, often measuring forty inches long. The bark is then dried in the sun, and afterwards made into bundles with pieces of bamboo twigs.

"Cinnamon is imported in bales, boxes, and chests, principally from Ceylon, but in part also from Madras, Tellicherry, and rarely from Java and other places.

"In order to preserve and improve the quality of the bark, black pepper is sprinkled amongst the bales of cinnamon in stowing them at Ceylon. (Percival.) Mr. Bennet states that ships are sometimes detained for several weeks, through the want of pepper to fill the interstices between the bales and the holds.

"When cinnamon arrives in London, it is unpacked and examined; all the mouldy and broken pieces are removed from it. It is then remade into bales. These are cylindrical, three feet six inches long, but of variable diameter, perhaps sixteen inches on the average. These bales are enveloped by a coarse cloth called *gunny*. The cinnamon in boxes and chests is usually the small, inferior, and mouldy pieces."

Composition of Cinnamon.

The constituents of cinnamon are *volatile oil*, *tannin*, *mucilage*, *colouring matter*, partly soluble in water and alcohol, but not in *ether*, *resin*, an *acid*, *starch*, and *lignin*.

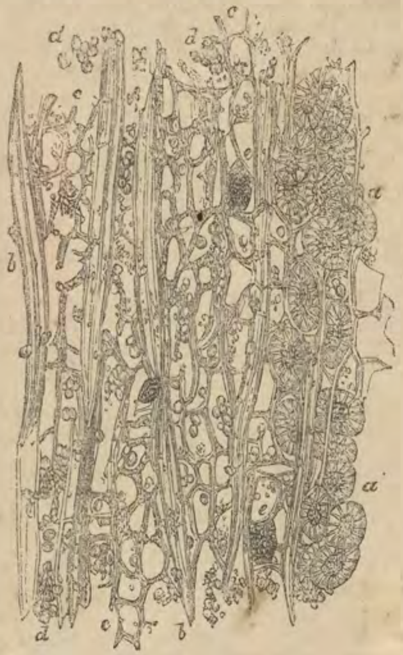
A decoction of cinnamon does not become blue on the addition of iodine; this is partly owing to the small quantity of starch present, and partly, it is supposed, to the presence of some principle (tannic acid?) which destroys the blue colour of the iodide of starch.

The cinnamon oil of commerce consists of two or more bodies. By exposure to the air, the oil absorbs oxygen; and cynnamic acid, two resins, and water are formed. With nitric acid it forms a white crystalline nitrate and a red oil, and with ammonia a solid crystalline amide is formed.

Structure of Cinnamon.

Cinnamon, under the microscope, presents a complicated and very distinct organisation, which is best seen in longitudinal sections, carried through the thickness of the bark.

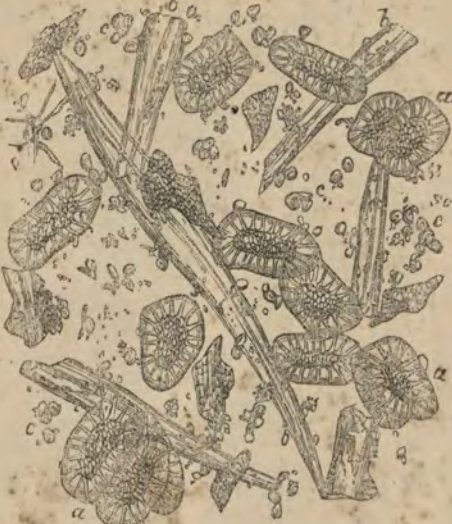
Fig. 161.



Longitudinal section of CINNAMON carried transversely through the bark, magnified 140 diameters.
a a, stellate cells ; *b b*, woody fibre ; *c c*, starch cells ; *d d*, starch granules ; *e e*, granular cinnamon-coloured cells or bodies.

On the outer or external surface of the section are observed numerous stellate cells, separable readily from each other, and similar to those which we have so often before described as occurring in other vegetable structures. These cells lie one upon the other in several layers, and form a considerable part of the thickness of the bark. They are situated in the intervals between the woody fibres ; they are of a quadrangular or oval form, having the long axes placed usually transversely to the bark, their breadth being greater than their depth. In whatever position they are viewed, both the central cavities and the rays which proceed from them are visible. Occasionally, though not usually, a few starch granules may be seen in the cavities of these cells. Proceeding from without inwards, these cells are succeeded by others, which are distinguished from the first by the absence of rays, by the thinness of their walls, and by the firmness with which they adhere to each other; they generally contain a few starch corpuscles. These cells, which form several series, complete the thickness of the bark.

Fig. 162.



Genuine CINNAMON *powder*, magnified 220 diameters. *a a*, stellate cells; *b b*, woody fibre; c c, starch granules.

Interspersed between both the first and second kinds of cells are numerous woody fibres, which are rather short, pointed at either extremity, and furnished with a central canal. It is these which impart the fibrous character to cinnamon, particularly observable in fractures of the bark.

The starch corpuscles of cinnamon are small, more or less globular, and furnished with a very distinct hilum, which has the appearance of a central depression. They usually occur singly, but sometimes united in twos or fours.

The quantity of starch in cinnamon is so small, that the decoction of the bark does not become blue on the addition of iodine.

Lastly, lying in the cavities of the most external of the second order of cells, are frequently to be observed deep cinnamon-coloured masses of granular texture.

The above structural particulars are all shown in *fig*. 161.

In ground cinnamon the several structures are disunited and broken. The stellate cells occur singly, or in groups of two, three, or more; the woody fibre is disengaged, and is scattered about, resembling somewhat, in form and appearance, the hairs which occur on many plants; the starch corpuscles are set free from their cells; and, lastly, the cinnamon-like masses may be seen in the field of the microscope, dispersed here and there. *Fig.* 162.

COMPOSITION AND STRUCTURE OF CASSIA.

Composition of Cassia.—Since cassia is so frequently substituted for cinnamon, it becomes necessary that we should acquaint ourselves with its composition and structure.

If tincture of iodine is added to a decoction of cassia, it turns blue, owing to the larger proportion of starch contained in it.

Oil of cassia possesses nearly the same properties as oil of cinnamon; it is said to be a thicker and heavier oil than that of cinnamon; and its odour and flavour are inferior.

Structure of Cassia.—Cassia—*Cinnamomum Cassia*—belongs to the same genus of plants as the true cinnamon, it is therefore not surprising that they should resemble each other so closely as they do. Notwithstanding their striking resemblances, there are characters, however, by which they may be discriminated.

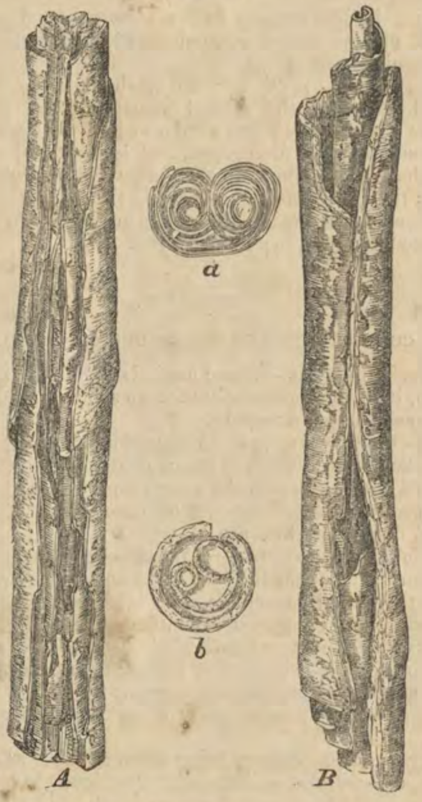
The bark of cinnamon is scarcely thicker than drawing-paper, and breaks with an uneven and fibrous margin; while each stick consists of eight, ten, or more pieces or *quills* of bark inserted one within the other.

Cassia bark is much stouter, being often as thick as a shilling: it breaks short, and without splintering. By these characters alone it is easy to distinguish cinnamon from cassia when in the whole state, as shown by the accompanying drawing.

But these barks differ also in colour and taste. Cinnamon is paler and browner than cassia, which is usually redder and brighter. The taste of one is sweet, mild, and aromatic, leaving no unpleasant impression on the tongue, while that of the other is less sweet, stronger, and is followed by a bitterness.

These characters, however, vary in different samples, so that it is impossible by these means alone to distinguish cinnamon from cassia when in powder, and we are not aware that any certain means have been pointed out for effecting the discrimination, especially when the

Fig. 163.



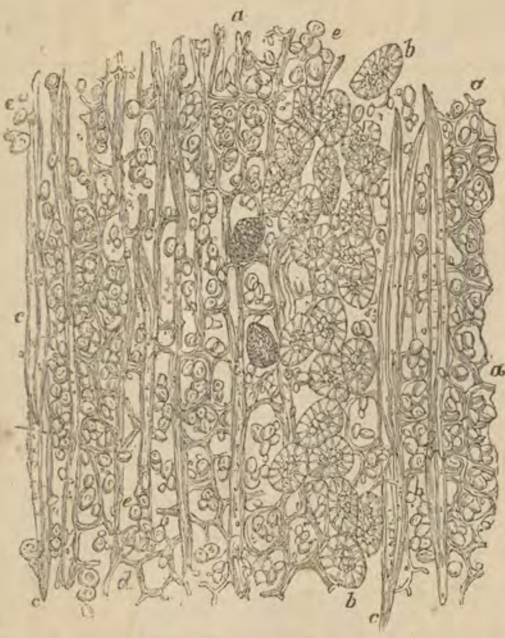
A, Stick of Cinnamon of the natural size and appearance, showing the thinness of the bark, and the manner in which the layers are enclosed one within the other; *a*, cross section of same, exhibiting more completely the number of the layers, and their disposition.

B, Stick of Cassia of the natural size and appearance, showing the thickness of the bark, and the manner in which the layers are enclosed within each other; *b*, cross section of same, exhibiting the disposition of the layers.

two are mixed in different proportions; but here again, as in so many other cases, the microscope affords us invaluable assistance.

Sections of cassia bark, viewed under the microscope, bear a close general resemblance to those of cinnamon, but differ in their greater width and the relative proportions of the several structures, particularly in the size and number of the starch corpuscles.

Fig. 164.



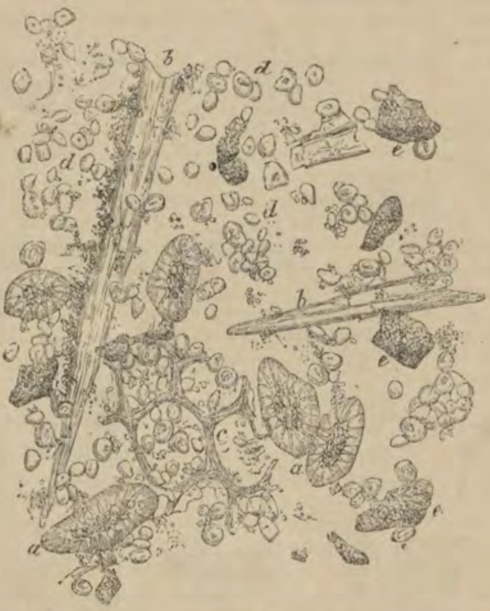
Longitudinal section of Cassia, carried transversely through the bark, magnified 140 diameters.
a a, cells of epidermis; *b b*, stellate cells; *d d*, starch cells; *e e*, starch granules; *f f*, granular, cinnamon-coloured masses.

We observe on the outer surface, as in cinnamon, the peculiar stellate cells, the cavities of which, however, much more commonly than those of cinnamon, are filled with well-developed starch corpuscles.

Lying next to these, we notice what may be termed the proper starch cells, usually crammed quite full of starch corpuscles, which, while they have the same general form as those of cinnamon, are yet two or three times larger, as well as many times more numerous.

The woody fibre occurs, as in cinnamon, interspersed between both descriptions of cells, and it does not appear to differ appreciably from that of cinnamon.

Fig. 165.



Genuine CASSIA *powder*, magnified 220 diameters; *a a*, stellate cells; *b b*, woody fibre; c c, starch cells; *d d*, starch granules; *e e*, granular masses.

Of the entire thickness of the bark, about one-fourth is formed by the stellate cells; the remaining three-fourths being made up of the starch-bearing cells.

In powdered cassia, therefore, as contrasted with powdered cinnamon, the stellate cells and woody fibre are much less abundant, while the starch granules are at the same time much larger, and far more numerous.

ON THE ADULTERATIONS OF CINNAMON AND CASSIA.

From an examination of the analyses of *Thirty-two* samples of cinnamon, it appeared that of the twelve *whole* cinnamons, *seven* were *genuine*, and that *five* consisted of nothing but *cassia.*

That the *essential oil* is sometimes abstracted, and the bark, after being reduced, sold either whole or in the ground state.

That of the *nineteen* samples of *ground* cinnamon, *three* consisted entirely of *cassia.*

That *ten* of the samples, or more than one half, were *adulterated*, the articles most frequently employed being either *baked wheat flour* or *sago meal*, separately or in combination, but *East India arrowroot* and *potato flour* were likewise detected each in one instance.

That of the above adulterated samples *three* consisted of *cassia* adulterated, and *seven* of *cinnamon* adulterated.

That *six* only of the *nineteen* samples were *genuine.*

In the prices charged for the samples of cinnamon examined, whether whole or in powder, genuine or adulterated, no constant difference was to be observed, and consequently the public suffers great loss by the substitution of cassia, which is so much cheaper, for cinnamon, and a still greater loss by the other sophistications.

The wheat flour and sago detected was generally baked, to make it resemble more nearly ground cinnamon or cassia, and thus the better escape detection.

On the Detection of the Adulterations of Cinnamon and Cassia.

The detection of the various adulterations of cinnamon and cassia is, in nearly all cases, easy enough by means of the microscope ; all that is requisite is that the observer should be acquainted with the structure and characters of genuine cassia and cinnamon, as well as of the articles employed to adulterate them.

The mixture of cassia with cinnamon of course constitutes an adulteration, but very frequently cassia is substituted for cinnamon. The mixture and substitution are both discoverable with the microscope by the difference in the size of the starch granules, but the substitution may be detected in other ways.

Thus when stick cassia is substituted for cinnamon, the substitution is known by the greater thickness of cassia bark.

Again, the decoction of cassia bark turns blue on the addition of iodine, when one of cinnamon similarly treated does not become blue.

It is stated that the oil is sometimes removed from cinnamon bark, this being subsequently ground to powder and mixed with genuine cinnamon.

This fraud may be discovered in two ways : the suspected cinnamon may be boiled in distilled water for a time and the oil distilled off; the distillate must next be evaporated to get rid of the water which passed over with the oil; lastly, the oil must be weighed, and the quantity obtained compared with that furnished by genuine cinnamon.

A more expeditious process is to examine the cinnamon with the microscope; if this has been acted upon by boiling water, the starch granules will be found to have lost their proper form, to have become distorted and irregular, while many of them are larger than natural. If the cinnamon has been subjected to the prolonged action of the water, the granules will have become so broken up and dissolved that they can no longer be detected.

The *import* customs duty is, on cinnamon, 2*d.* per lb. The quantity entered for home consumption (which forms but a fraction, about 1-13th, of the quantity imported) was in 1853, 37,694 lbs.; in 1854, 54,056 lbs.; in 1855, 42,943 lbs.; in nine months of 1856, 22,771 lbs.

On cassia (lignea or bark), 1*d.* per lb.; cassia buds and fistula, free. Were entered for home consumption (again but a fraction, about 1-6th to 1-7th, of quantity imported) in 1853, 136,363 lbs.; in 1854, 124,303 lbs.; in 1855, 110,219 lbs.; in nine months of 1856, 90,197 lbs.

NUTMEGS, AND THEIR ADULTERATIONS.

There are three species of *Myristica*, which furnish nutmegs. That which yields the best description, *Myristica fragrans*, forms a tree from twenty to twenty-five feet high, somewhat similar in appearance to a pear tree.

The fruit is smooth externally, pear-shaped, and about the size of an ordinary peach. It consists, first, of an outer fleshy covering, called the *pericarp*, which when mature separates into nearly equal longitudinal parts, or valves; secondly, of the *aril*, or *mace*, which, when recent, is of a bright scarlet colour; and thirdly, of the seed proper, or *nutmeg*. This is enclosed in a shell, which is made up of two coats: the outer is hard and smooth; the inner, thin, closely invests the seed, sending off prolongations, which enter the substance of the seed, and which, being coloured, impart the marbled or mottled appearance characteristic of nutmeg.

There are two kinds of nutmegs met with in commerce. The first, called the *true*, *round*, *cultivated*, or *female* nutmeg, is the product of *Myristica fragrans*.

The second kind of nutmeg is called the *false*, *long*, *wild*, or *male* nutmeg, and is the produce chiefly of *Myristica fatua*; but a kind of nutmeg which is also called wild, is obtained from *Myristica Malabarica*.

In the Banda Islands, three crops or harvests of nutmegs are obtained in the year; the principal gathering is in July or August; the second in November; and the third in March or April.

The fruit is gathered by means of a barb attached to a long stick; the mace is separated from the nut, and separately cured.

On account of their liability to the attacks of an insect known as the *nutmeg insect*, considerable care is required in drying them. They should be dried in their shells, as they are then secure from the insect. They are placed on hurdles, and smoke-dried over a slow wood fire for about two months. In the Banda Islands, they are first dried in the sun for a few days. When the operation of drying is complete, the nuts rattle in their shells; these are cracked with mallets, and the damaged, shrivelled, or worm-eaten nuts removed.

"To prevent the attacks of the insect, the nuts are frequently limed. For the English market, however, the brown or unlimed nutmegs are preferred. The Dutch lime them by dipping them into a thick mixture of lime and water; but this process is considered to injure their flavour. Others lime them by rubbing them with recently-prepared, well-sifted lime. This process is sometimes practised in London."

Composition of Nutmegs.

Nutmegs contain both a fixed and a volatile oil. The *fixed oil* is prepared by beating the nutmegs to a paste; this is subjected, enclosed in a bag, to the vapour of water, and the oil afterwards expressed by means of heated plates. It is imported in cakes which have somewhat the size and form of common bricks, and are covered with leaves. The fixed oil procured in this manner contains a portion of the volatile oil, from which its colour and fragrant odour are derived.

The *volatile oil*, on the presence of which the flavour and aroma of nutmegs principally depend, is procured by distillation in water; the produce thus obtained at Apothecaries' Hall, London, is usually 4·5 per cent. Now, nutmegs are frequently deprived of a portion of their essential oil by distillation, and after being well limed, are again sent into the market in this comparatively valueless state.

Bonastre's Analysis.[*]

Volatile oil	6·0
Liquid fat	7·6
Solid fat	24·0
Acid	0·8
Starch	2·4
Gum	1·2
Ligneous fibre	54·0
Loss	4·0
	100·0

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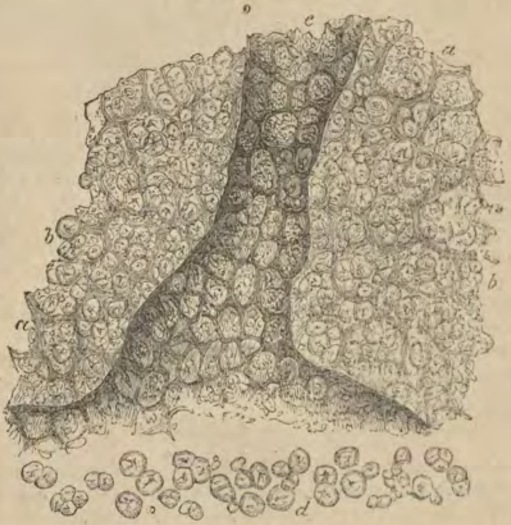
[*] Journ. de Pharm. 1823, t. ix. p. 281.

Structure of Nutmegs.

Nutmegs, under the microscope, present peculiarities of structure, by which they may be distinguished, even in powder, from most other vegetable productions. A thin section, viewed under an object glass magnifying 220 diameters, is seen to consist of minute angular cells. Those forming the white or *uncoloured* part of the nut, present, previous to the action of water upon them, an opalescent appearance, from the quantity of oil enclosed in them; their cavities contain in addition much starch, in the form of small but distinct granules, mostly of a rounded shape; but occasionally a few of the granules are angular; and all have well-marked central depressions.

Fig. 166.
SECTION OF NUTMEG.
(Magnified 220 diameters.)



a a, cells forming the white or uncoloured portions of the nutmeg; they are seen to contain numerous starch granules. *b b*, the starch granules. *c*, a portion of one of the veins formed by the inversion of the inner coat of the seed vessel or *endopleura;* it consists of coloured cells, containing oil only. *d*, loose starch granules magnified 420 diameters.

The cells forming the *coloured*, vein-like portion of the nut, differ from the other cells in colour and in being destitute of starch, containing apparently only a small quantity of oil.

ON THE ADULTERATIONS OF NUTMEGS.

Since nutmegs are never sold in the powdered state, they are not liable to adulteration by admixture with foreign ingredients, like several of the spices which have been already noticed, as ginger, cinnamon, and cassia; nevertheless, they are subjected to a process which impairs their value and quality as much as though they had been actually adulterated in the same manner.

The wild nutmeg obtained from the *Myristica Malabarica* has scarcely any flavour or odour, and according to Rheede, is of the size and figure of a date. "The Turkish and Jewish merchants," writes Rheede, "mix these nutmegs with the true long ones, and the mace with good mace, selling them together. They also extract from these inferior articles an oil, with which they adulterate that of a more genuine quality."

The work of M. Chevallier, entitled "Dictionnaire des Altérations et Falsifications des Substances Alimentaires, Medicamenteuses, et Commerciales," in treating of nutmegs, contains the following observations, under the head of "Falsifications:"—

"Nutmegs are sometimes mixed with riddled nuts, eaten by insects, and become brittle; the small apertures are then closed with a kind of cement, formed of flour, oil, and the powder of nutmegs. This paste has even served to fabricate false nutmegs, inodorous and insipid. The workmen of Marseilles have even made them of bran, clay, and the refuse of nutmegs: these nutmegs, placed in contact with water, soften down in that liquid.

"The worm-eaten nuts are equally insipid, and almost inodorous; sometimes they have a mouldy odour."

Eighteen samples of nutmegs were subjected to examination, the result being that *in no case had the essential oil been abstracted.*

On the Detection of the Adulterations of Nutmegs.

The only adulteration, excepting that by admixture with wild nutmegs, to which it appears that nutmegs are liable—and this doubtless is of rare occurrence—is by means of the artificial or factitious nutmegs mentioned by M. Chevallier.

These may be readily discovered by soaking them in water, when, of course, they would readily break down.

The differences between the cultivated and wild nutmegs have already been described.

The nutmegs from which the oil has been abstracted may be recognised by the presence of punctures on the surface, and by their much greater lightness.

It is singular that the starch granules of nutmeg are but little affected by boiling; so that this means of discrimination, so satisfactory in the case of cinnamon, cassia, and some other spices, is of little or no value in the present instance.

Of this remarkable circumstance it is not easy to afford an explanation; it probably depends upon the difficulty with which the boiling water makes its way into the substance of the nut, in consequence of its hard texture and the large quantity of fixed oil contained in it.

The differential duties on wild and cultivated nutmegs offer a premium for the substitution of the inferior for the superior article.

Import duty on nutmegs, 1*s.* per lb.; wild, so called, in shell, 3*d.* per lb.; wild, not in shell, 5*d.* per lb.

Taken for home consumption in 1854, 206,049 lbs.; in 1855, 189,596 lbs.; in nine months of 1856, 154,380 lbs.

MACE, AND ITS ADULTERATIONS.

As there are two kinds of nutmeg, so are there two kinds of mace, the produce of the same plants: thus, there is true, or cultivated mace, and false, or wild mace.

Wild or false mace is of a dark-red colour, and deficient in flavour and aroma.

Composition.

The composition of mace is exhibited in the following analysis by N. E. Henry:—

Volatile oil.
Red fat oil, soluble in alcohol.
Yellow fat oil, insoluble in alcohol.
Alcoholic extractive.
Amiden.
Ligneous fibre with lime.

Structure of Mace.

Viewed under the microscope, mace presents a structure very distinct from that of the nutmeg itself.

Covering the surface of the blades is a delicate membrane consisting of a single layer of cells; they are tubular, much elongated, taper at either end to a point, and resemble in size and form, although not in delicacy of texture, ordinary woody fibre. The long diameters of the cells are disposed vertically on the surface of the mace.

But the chief substance is made up of other cells differing in size and form from those already noticed; these contain fixed oil, and much starch.

Imbedded in the midst of these cells are larger cells, spaces, or *re-*

ceptacles, which, in thin sections, whether made crosswise or lengthwise, appear as apertures. These contain the essential oil of mace.

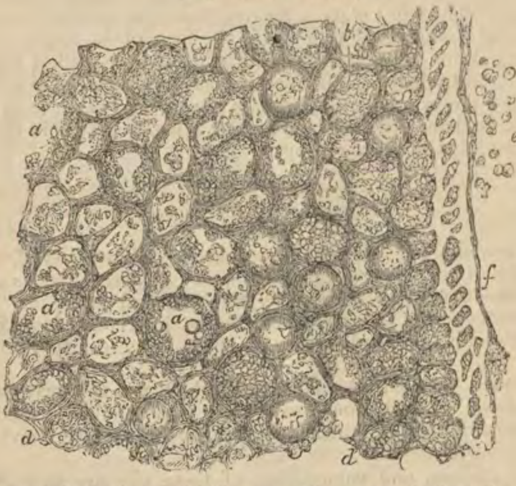
Scattered here and there may be seen, both in transverse and longitudinal sections, small bundles of woody fibre, of a brownish colour, enclosing one or two small spiral vessels. In transverse sections, the ordinary starch cells are perceived to be arranged round the bundles in a radiate manner.

The structure of mace is exhibited in the annexed wood-cut.

Fig. 167.

TRANSVERSE SECTION OF MACE.

(Magnified 220 diameters.)



a a, receptacles for the essential oil; many of them appear in the section as apertures, and are represented in the figure as such. *b b*, the same, exhibiting the appearance of closed cells, from the circumstance of their not being cut into; the colouring matter of mace is located chiefly in these cells or receptacles. *c c*, large air-bubbles usually observed in sections immersed in water. *d d*, cells filled with starch corpuscles. *e*, the starch corpuscles loose, magnified 420 diameters. *f*, the cells forming the delicate coat or cuticle investing mace.

ON THE ADULTERATIONS OF MACE.

Like the nutmeg, mace may be deprived, by distillation, of its essential oil.

The only adulteration of mace known to be practised is that by admixture with wild mace; this is distinguished by its dark-red colour and by its deficiency in flavour and aroma.

Of *Twelve* samples of mace subjected to examination *the whole were genuine.*

Import duty, 1*s.* per lb.

Home consumption, in 1854, 25,584 lbs.; in 1855, 28,562 lbs.; in nine months of 1856, 15,267 lbs.

CLOVES, AND THEIR ADULTERATIONS.

Cloves are the unexpanded flower-buds of *Caryophyllus aromaticus*, a tree from fifteen to thirty feet in height, one of the Myrtaceæ or myrtle tribe. The word *clove* is derived from *clou*—French for nail, from a fancied resemblance to a nail in the form of the clove.

The flower-buds are arranged on terminal flower-stalks; they are either gathered by hand or obtained by beating with bundles of reeds, in which case cloths are spread beneath the trees to catch them; they are afterwards dried either by the fire, or, what is better, in the sun; they are imported in casks or bags.

Composition of the Clove.

Cloves contain, according to the analysis of Trommsdorf, *volatile oil*, 18; *almost tasteless resin*, 6; *tannin*, 13; *difficultly-soluble extractive with tannin*, 4; *gum*, 13; *woody fibre*, 28; and *water*, 18.

The volatile oil is obtained from cloves by repeated distillation. The yield on an average is said to be from seventeen to twenty-two per cent.

It has been ascertained that the oil which was formerly regarded as a simple oil, is really composed of two volatile oils, possessing different qualities, one of which is lighter, and the other heavier than water.

The characters and composition of these oils are thus given in Pereira's "Materia Medica," ed. 1. part ii. p. 1093.:—

"*a. Light Oil of Cloves* (*Clove-Hydro-Carbon*).—Colourless sp. gr. 0·918. Incapable of combining with bases, but absorbing hydrochloric acid gas without yielding a crystalline compound. It consists of $C_{10} H_8$; hence it is isomeric with oil of turpentine.

"*β. Heavy Oil of Cloves* (Clove Acid; Engenic Acid).—It is colourless when recently prepared, but becomes coloured by age. Its specific gravity, according to Bonastre, is 1·079. It combines with alkalies to form crystalline salts (*alkaline eugenates*, *clove-oil alkalies*). If a salt of iron be added to one of these, it yields a blue, violet, or reddish compound (*a ferruginous eugenate*), varying somewhat according to the nature of the ferruginous salt used; thus the protosulphate of iron yields a lilac, the persulphate a red, which becomes violet and afterwards blue; while the sesquichloride gives a vinous, which turns to red (Bonastre). Nitric acid reddens clove acid."

The unexpanded flower-buds are not the only parts of the tree which are aromatic, as the footstalks and fruit or seed vessels are likewise so to some extent.

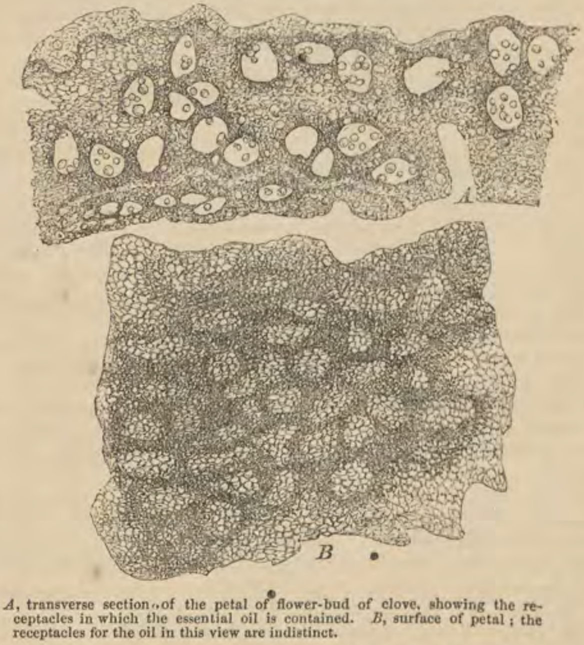
The peduncles, or *footstalks*, according to Guibourt, are sometimes substituted for cloves by distillers of the oil.

The fruit, *mother-cloves* as they have been called, are occasionally met with in commerce; they have the shape of the olive, but are smaller, and possess the odour and taste of the clove in a mild degree.

Fig. 168.

PETAL OF CLOVE-BUD.

(Magnified 60 diameters).



A, transverse section of the petal of flower-bud of clove, showing the receptacles in which the essential oil is contained. *B*, surface of petal; the receptacles for the oil in this view are indistinct.

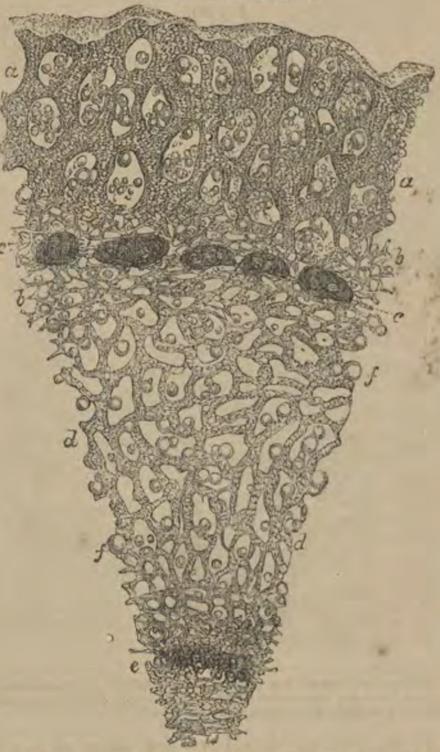
Structure of the Clove.

The minute structure of cloves is extremely characteristic. The rounded head or *bud* consists of the unexpanded petals; if a transverse section of one of these be made, it will be seen to be composed of cellular tissue, in the midst of which are numerous receptacles for the essential oil; these extend through the whole thickness of the leaf, being usually three or four deep.

Fig. 169.

TRANSVERSE SECTION OF FLOWER-STALK OF THE CLOVE.

(*Magnified* 60 diameters.)



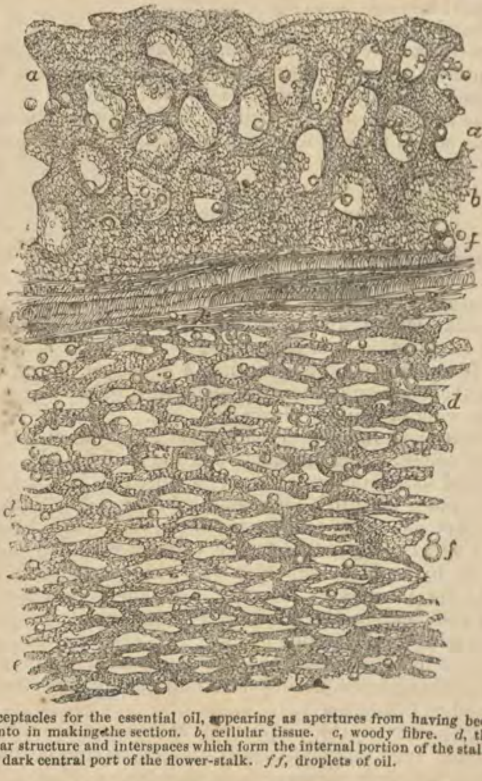
a, receptacles for the essential oil; the section being a thin one, they present the appearance of apertures, in consequence of being opened into. *b b*, cellular tissue surrounding the woody fibre. *c c*, bundles of woody fibre. *d*, the tubular structure and interspaces, of which the internal portion of the stalk is formed. *e*, the centre of the stalk; it appears dark under the microscope, the structure being obscure. *f f*, droplets of oil.

When the petal is viewed on the surface, the receptacles are seen but indistinctly, being obscured by the cellular tissue of which the surface of the petal is formed. *Fig.* 170.

Fig. 170.

LONGITUDINAL SECTION OF FLOWER-STALK OF THE CLOVE.

(Magnified 60 diameters.)



a a, receptacles for the essential oil, appearing as apertures from having been cut into in making the section. *b*, cellular tissue. *c*, woody fibre. *d*, the tubular structure and interspaces which form the internal portion of the stalk. *e*, the dark central port of the flower-stalk. *f f*, droplets of oil.

In a transverse section of the *flower-stalk*, viewed with an object-glass of one-inch focus, the following appearances present themselves :—

In the oerut third of the section, numerous large holes are observed; these are the divided receptacles; next to these, passing inwards, are bundles of woody fibre, forming a narrow circle in the interior of the stalk; extending from these to near the centre of the stalk is a tissue formed of numerous tubular cells, with large spaces between them. The receptacles, as well as the tubular cells and interspaces, contain essential oil, visible in sections immersed in water, in the form of innumerable droplets. *Fig.* 169.

Longitudinal sections exhibit a nearly similar structural arrangement. *Fig.* 170.

Cloves contain scarcely any starch.

The clove-stalks present a structure somewhat similar to that of cloves themselves; that is, they consist of cellular tissue, hollowed out here and there into receptacles for the essential oil; but, in addition, the stalks are provided with an epidermis, or coating of the stellate cells, which are of such frequent occurrence in different kinds of bark.

ON THE ADULTERATIONS OF CLOVES.

Cloves are but seldom sold in powder, and hence the liability to adulteration is greatly lessened; they are, however, occasionally met with in that state.

Clove-stalks, although very inferior, contain some of the active properties of cloves, and, as already noticed, are occasionally used by distillers for procuring the essential oil of cloves. We have reason to believe that in some cases the stalks are ground up, and mixed with the powder of genuine cloves.

The quality and value of cloves are not unfrequently impaired, like some other spices, by the abstraction of the essential oil.

This fraud used to be extensively practised in Holland, the *drawn* cloves, for more effectual concealment, being mixed with others of good quality; and even, in some instances, the trouble being taken to restore as nearly as possible to the exhausted cloves their original appearance, by rubbing them over with some common oil.

Twenty-five samples of cloves, whole and in powder, were subjected to examination, the results were that *one* only of the powdered cloves contained a proportion of clove-stalks, while from none of the whole cloves had the essential oil been abstracted.

The volatile oil itself, as imported into this country from India, has been found to be adulterated.

Mr. M'Culloch, on the authority of Milburn, states that the oil imported from India contains nearly half its weight of an insipid expressed oil, which is discovered by dropping a little into spirits of wine, and on shaking it the genuine oil mixes with the spirit, and, the insipid separating, the fraud is detected.

Cloves readily imbibe moisture, whereby their weight becomes greatly increased, a fact of which dishonest dealers have not failed to avail themselves.

On the Detection of the Adulterations of Cloves.

The adulteration of powdered cloves with clove-stalks is readily detected by means of the microscope, which will reveal the presence of the stellate cells of the stalk. If the essential oil has been removed, the cloves will be dry and bitter, no oil appearing on the surface when the cloves are pressed with the nail.

The quantity of essential oil may be estimated by distillation; genuine cloves yield from 17 to 22 per cent. of oil.

Adulterations with foreign vegetable substances are all discovered by the microscope.

Duty, 2*d.* per lb. Home consumption in 1854, 179,407 lbs.; in 1855, 220,649 lbs.; in nine months of 1856, 151,254 lbs.

PIMENTO OR ALLSPICE, AND ITS ADULTERATIONS.

Pimento, Jamaica Pepper, or Allspice, is the berry or fruit of the *Eugenia Pimento*, one of the *Myrtaceæ.* It grows in the West Indies, and principally in Jamaica, especially on the hills on the north side of that island. It forms a beautiful tree, which attains some thirty feet in height, and is planted in regular walks, which are named *Pimento walks.*

The fruit is gathered after it has attained its full size, but while still green; it is usually sun-dried, but sometimes kiln-dried on sheets: in drying, the colour of the fruits change from green to reddish-brown, when ripe, the berry becomes black or dark-purple in colour, and is glutinous, and consequently in that state unfit for preservation.

Composition of Allspice.

As in the case of cloves, the essential oil of pimento is a mixture of two oils—a light and a heavy oil. The properties of these are thus described in Pereira's "Materia Medica:"—

"By distillation with water, allspice, like cloves, yields two volatile oils—the one lighter, the other heavier than water. The oil of pimento of the shops is a mixture of these; except in odour, its properties are almost identical with those of oil of cloves. By distillation with caustic potash, the *light oil* is separated; the residue mixed with sulphuric acid, and submitted to distillation, gives out the heavy oil.

"*a. Light Oil of Pimento* (*Pimento-Hydro-Carbon*) has not, to my knowledge, been previously examined. Its properties appear to be similar to those of the light oil of cloves. It floats on water and on liquor potassæ, and is slighty reddened by nitric acid. Potassium sinks in, and is scarcely, if at all, acted on by it.

"β. *Heavy Oil of Pimento* (*Pimentic Acid*).—Very similar to clove-acid. It forms with the alkalies crystalline compounds (*alkaline pimentates*), which become blue or greenish on the addition of the tincture of the chloride of iron (owing to the formation of a *ferruginous pimentate*). Nitric acid acts violently on and reddens it."

Bonastre*, in 1825, published the following analysis of the composition of pimento berries:—

	Husks.	Kernels.
Volatile oil	10·0	5·0
Green oil	8·4	2·5
Solid fat oil	0·9	1·2
Astringent extract	11·4	39·8
Gummy extract	3·0	7·2
Colouring matter	4·0	
Resinous matter	1·2	
Uncrystallisable sugar	3·0	8·0
Malic or gallic acid	0·6	1·6
Lignin	50·0	
Saline ashes	2·8	1·9
Water	3·5	3·0
Loss	1·6	1·8
Red matter insoluble in water	- -	8·8
Pellicular residue	- -	16·0
Brown flocculi	- -	3·2
Total	100·0	100·0

Complicated and complete as the above analysis would appear to be, it yet does not embrace the starch which is contained in the seeds in large quantity. Braconnet, however, detected the presence of starch, and estimates it as forming nine per cent. of the seeds.†

Mr. Whipple estimates the yield of pimento oil to be about 4·37 per cent. of the weight of the seed.

Structure of Allspice.

As in the case of other seeds, the pimento berry is divisible into husk and seed, or seeds proper.

The husk is thick, and, when dried, soft and brittle; it sends off from its inner surface a prolongation which forms a septum, and divides the interior into two parts, or cells.

Vertical sections of the *husk*, viewed under the microscope, present the following structures.

On the outer part of the section are seen several large cells or *receptacles* for the essential oil, sometimes two or three deep; more internally, numerous stellate cells, attached to and imbedded in cellular tissue, occur; next to these are bundles of woody fibre, and delicate spiral vessels; while the deepest or innermost part of the section consists of cellular tissue only.

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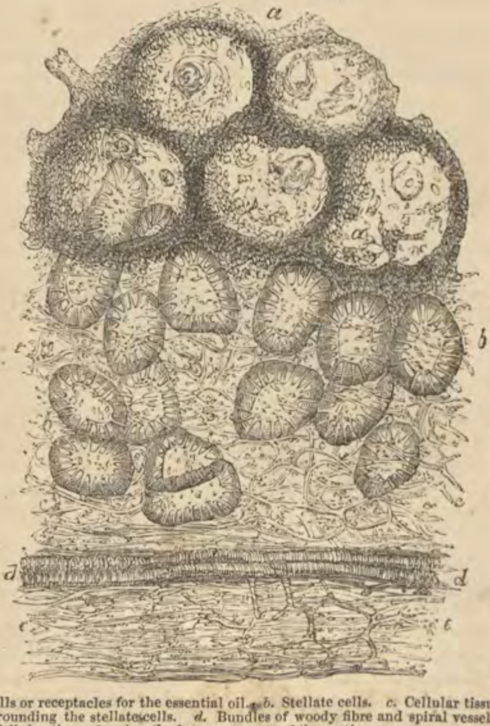
* Journ. de Chim. Méd. i. 210.

† Duncan, Edinb. Dispens.

Fig. 171.

Vertical Section of Husk of Pimento Berry.

(Magnified 220 diameters.)



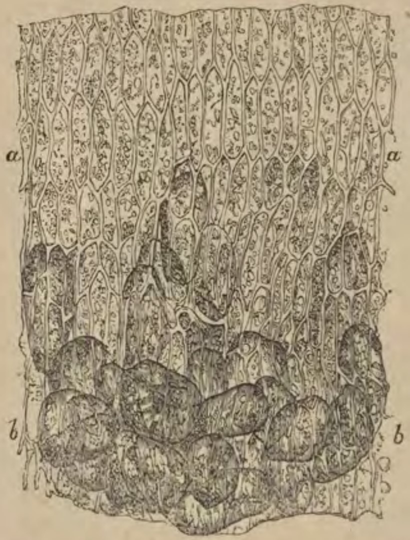
a. Cells or receptacles for the essential oil. *b*. Stellate cells. *c*. Cellular tissue surrounding the stellate cells. *d*. Bundles of woody fibre and spiral vessels. *e*. Cellular tissue forming the innermost part of the section.

Occupying each of the cells formed by the husk, is a small flattish seed of a dark brown or chocolate colour. After maceration, two membranes may be separated, although with some difficulty, from the surface of the seed. The most external of these is thin and delicate, and consists of a single layer of elongated and angular cells. The internal tunic is composed of several layers of large corrugated and coloured cells; it is to these that the dark colour of the surface of the seed is due; when viewed under the microscope, they exhibit a characteristic port wine tint.

Fig. 172.

Portion of the Membranes on Surface of the Seed Proper.

(Magnified 220 diameters.)



a. External membrane, consisting of a single layer of elongated and angular cells. *b*. Internal membrane, made up of several layers of large port wine coloured cells.

The structure of the *seed* proper, as displayed in vertical sections, is as follows:—

Running round the outer part of the section is a single layer of large receptacles, the remaining thickness being made up of angular and transparent cells, the cavities of which are filled with numerous well-defined starch granules.

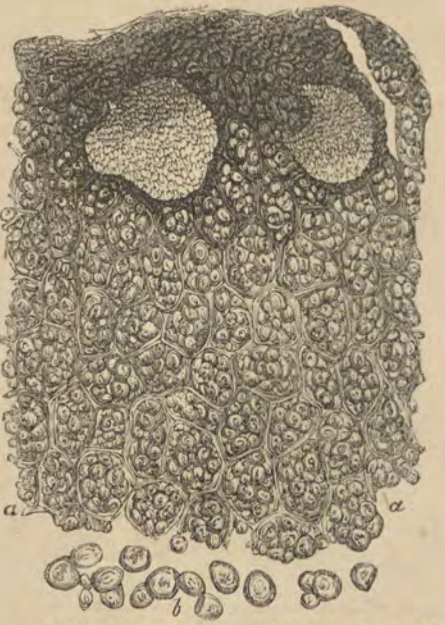
When pimento berries are reduced to powder, the whole of the foregoing structures become disunited, broken up, and variously intermixed. The port wine coloured cells are particularly conspicuous, and afford a character by which the nature of the powder may be at once determined.

The several structures above mentioned, as they appear in genuine ground pimento powder or allspice, are represented in *fig*. 174. on the next page.

Fig. 173.

Vertical Section of the Seed Proper, of Pimento Berry.

(Magnified 220 diameters.)



In the upper part of the figure, two of the *receptacles* for the oil are exhibited; and in the lower part, *a a*, the cells containing the small rounded starch corpuscles; *b*, loose starch corpuscles, magnified 420 diameters.

ON THE ADULTERATIONS OF ALLSPICE.

Of *Twenty-one* samples of ground allspice subjected to examination one only was adulterated with *mustard husk*, a result probably mainly attributable to the great cheapness of this spice.

On the Detection of the Adulterations of Allspice.

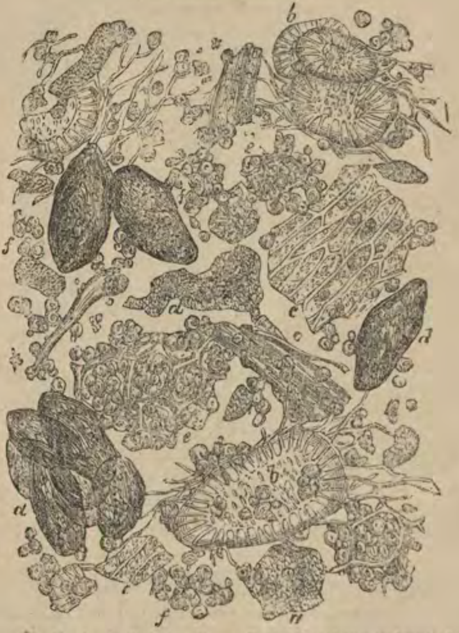
The adulteration with mustard husk is one which is very readily discoverable by means of the microscope, the structural peculiarities of which will be found described under the article Mustard.

The duty on pimento is *5s.* per cwt. Wholesale price about *6d.* per pound. Entered for home consumption in 1854, 3,635 cwts.; in 1855, 3,535 cwts.; in nine months of 1856, 2,781 cwts.

Fig. 174.

GROUND PIMENTO, OR ALLSPICE.

(Magnified 220 diameters.)

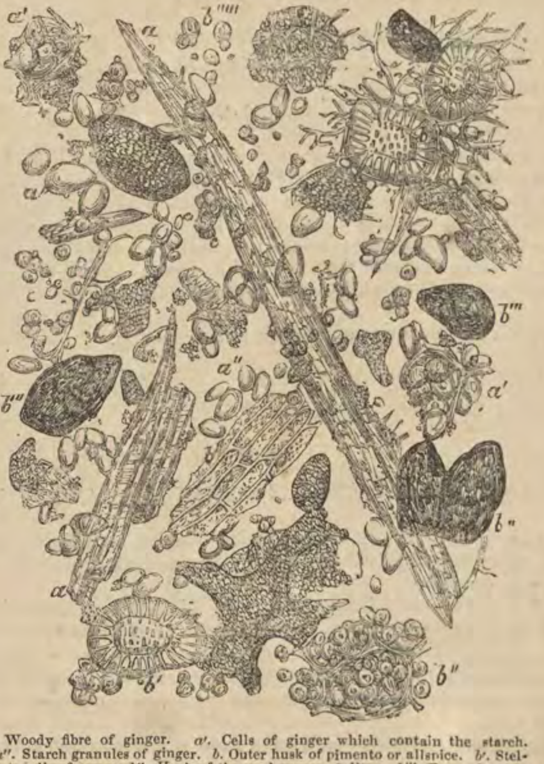


a. Fragments of husk. *b.* Stellate cells. *c.* External coat or membrane of seed proper. *d.* Port wine coloured cells, which form the second membrane of seed. *e.* Cells of the seed, which contain the starch granules. *f.* Loose starch corpuscles.

MIXED SPICE, AND ITS ADULTERATIONS.

Mixed Spice, as the name implies, is a mixture in different proportions of several spices; those of which it is usually composed are ground ginger, pimento or allspice, with cassia or cinnamon, and sometimes a small quantity of powdered cloves. Such are the usual ingredients which enter into its composition. In some rare cases, however, it may contain other spices, as mace or nutmeg; but whatever the constituents, and in whatever proportions they are employed, mixed spice, when genuine, should consist entirely of a combination of spices, and should not contain a particle of farinaceous matter other than that proper to the articles composing it. Thus it should never contain *wheat flour*, *potato farina*, or *sago meal*, and whenever any of these are present, the article is to be considered and treated as adulterated.

Fig. 175.
GENUINE MIXED SPICE.
(Magnified 220 diameters.)



a. Woody fibre of ginger. *a'*. Cells of ginger which contain the starch. *a''*. Starch granules of ginger. *b*. Outer husk of pimento or allspice. *b'*. Stellate cells of same. *b''*. Husk of the seed proper of ditto. *b'''*. Port wine coloured cells of ditto. *b''''*. Starch cells; and *b'''''*, starch granules of same. c. Starch granules and fragments of powdered cinnamon.

The above engraving represents the structure of the several ingredients of which genuine mixed spice is usually formed.

ON THE ADULTERATIONS OF MIXED SPICE.

Of the *Twenty-six* samples of mixed spice subjected to microscopic examination, no less than *sixteen*, or considerably more than one half, were adulterated; and hence it is seen that, of all the spices, mixed spice is the most liable to adulteration.

The substances employed were *wheat flour* in five cases, *ground rice* in two, *sago* in four, *potato flour* in one, and *vegetable substances* undetermined in three of the samples.

On the Detection of the Adulterations of Mixed Spice.

The whole of the adulterations of mixed spice are discoverable by means of the microscope: the characters of wheat flour are described and figured at p. 243.; of rice, at p. 255.; of sago, at pp. 324—5.; and of potato flour at p. 320.

Fuller details respecting the adulteration of spices will be found in the author's work entitled "Food and its Adulterations."

The present affords an additional instance of what we have so frequently before observed—namely, that the higher the price of any article, the more it becomes subject to adulteration.

It thus again appears that the public and the revenue are extensively defrauded through the adulteration of the majority of the spices sold.

Duty on ground spice unenumerated, 1*s*. per lb.

ISINGLASS, AND ITS ADULTERATIONS.

ISINGLASS is the air bag, or swimming bladder, sometimes called the sound, of various fish, chiefly of the sturgeon tribe, and belonging to the genus *Acipenser*.

This bag is a membrane filled with air, situated near the spine, above the centre of gravity. In most fish it communicates with the œsophagus, or stomach, by a duct, which is known as the *ductus pneumaticus;* in others, the duct is imperforate: occasionally there are two sacs, one anterior to the other, and communicating by a short tube.

The air bag is made up of an external or peritonæal covering; a middle, fibrous, and in some cases muscular coat; and an internal, highly vascular membrane.

The following are the principal species of fish from which Russian isinglass is derived:—*Acipenser Huso* or the *Beluga*, *A. Gouldenstadtii* or the *Osseter*, *A. Ruthenus* or the *Sterlet*, *A. Stellatus* or the *Sewruga*, *Silurus Glanis*, and *Siprinus Carpio.*

In addition to the above, isinglass is obtained in different parts of the world from several other kinds of fish. In New York, from the *Labrus Squeteague*, of Mitchell. In New England it is procured from the intestines of *Morrhua vulgaris*, or the common cod, this form being denominated *ribbon isinglass.* In the Brazils, it is obtained from a large fish, probably a species of *Silurus;* and in Iceland, from the *Cod* and *Lota Moloa* or *Ling.*

For an account of the fisheries and the mode of preparation or drying of the swimming bladder, the reader is referred to the author's work "Food and its Adulterations."

The principal kinds of isinglass are *leaf*, *short staple*, *long staple*, and *book* isinglass.

Samovey short staple and book isinglasses are usually of inferior quality.

152,000 lbs. of isinglass are, on the average, shipped every season from Russia.

In addition to the isinglass imported from Russia, a vast quantity is annually received from the Brazils, and the East and West Indies. It is, however, greatly inferior to the descriptions we have noticed. Indeed, *Brazilian isinglass* is only fit for fining purposes, and for such it is almost wholly bought up by the proprietors of large brewing establishments, who consume nearly the entire quantity imported.

Manufacture of Isinglass.

On the arrival of the isinglass into this country, the best kinds are submitted to a course of preparation before they are ready for consumption.

The Beluga leaf is closely examined, and all discoloured parts cut away; the cuttings, and other pieces not deemed good enough for the *best*, are placed aside as *seconds* or *thirds*. These, in some cases, are used for fining the better description of ales, but more generally for wines, liqueurs, &c. It is also rolled and cut into shreds for domestic purposes, where colour is not an immediate object.

Purse isinglass is mostly sold to the brewers, who consume a vast quantity in the fining of their several beverages.

Long and short staple isinglass is extensively demanded by cider makers, confectioners, and others, to whom it is sold in the same state as imported into this country.

Leaf isinglass taken from the Beluga, after having been picked from all impure or discoloured pieces, constitutes the very best article, either for dietetical use, or for the higher class of clarifying purposes. This description of isinglass has to undergo a process of manufacture before it is ready for use. What are termed perfect specimen leaves are nearly round, the bladder having been opened longitudinally, about two feet in circumference, and weigh from eight to sixteen ounces, according to the thickness of the sound. It is not uncommon, however, to meet with heavier samples, some having been known to reach four pounds.

A steam engine of some eight or ten horse power is generally used under the present method of preparing isinglass, the adjunct machinery consisting of a series of powerful rollers, arranged in pairs in a manner resembling those used for expressing the juice from the sugar cane. The rollers when in motion are fed with leaf isinglass as fast as possible, which, in passing between the two rollers, becomes amalgamated and spread out, and is expelled from the opposite side of the rollers in one continuous sheet. The isinglass thus rolled is called "ribbon," but it is not yet ready for the process of cutting.

The sheet or "ribbon" is probably a sixth, eighth, or tenth part of an inch in thickness, and as it is necessary to reduce it until it is as thin as writing paper, it is passed through rollers more closely set, until, as the thickness diminishes, the desired result is obtained; the width of the "ribbon," of course, increasing.

It is to be remarked, that in rolling, the ribbon, being confined to the width of the rollers, generally about two feet, increases only lengthways, and, when completed, can be folded or rolled up in the same manner as a length of common linen.

After a brief delay, for the purpose of drying, the next and last process of cutting is effected. By the introduction of modern machinery, this part of the preparation of isinglass is performed with surprising celerity, and the material is cut into very fine shreds.

The cutting machine is a cylinder with some five or six keen-edged blades fixed in a tangential direction to the cylinder. The same engine which serves to roll out the isinglass, as already described, suffices to turn this little machine at the rate of some 800 or 1000 revolutions per minute; taking a low estimate, we will suppose it turns 800 times. On examining the cylinder we find five or six blades set in it, and as each of these knives severs a shred from the width of the "ribbon," while the cutting process is going on, it follows that four or five thousand shreds are cut in the short space of one minute.

Such is the plain and simple method of preparing cut isinglass.

There are, however, many consumers who still prefer the old-fashioned style of hand-cut isinglass. In this case, the thin leaf is pulled to pieces with the fingers or divided into strips with scissors, a work mostly performed by women.

The shreds of isinglass softened in cold water and examined in the microscope, are seen to possess a fibrous structure, a few vessels, granular cells, and nuclei being scattered here and there: it is, in fact, an organised substance. *Fig.* 176.

On the Adulterations of Isinglass.

The principal adulteration of isinglass is with gelatine, an article in every respect much inferior to isinglass.

Usually shreds of gelatine are mixed with those of isinglass. Occasionally the gelatine is incorporated with the isinglass while it is in sheets.

Most frequently, however, gelatine is substituted for isinglass. The best isinglass, of course, is Russian; this is often deteriorated by admixture with a very inferior article termed *Brazilian isinglass;* in other cases, this is substituted for the better and more valuable description of isinglass.

Results of the Examination of Samples.

Of *Twenty-eight* samples of isinglass subjected to examination, ten, or more than one third, of the samples consisted entirely of GELATINE.

On the Detection of the Adulterations of Isinglass.

Between isinglass and gelatine several well marked distinctions exist; some of these are sufficiently simple to enable the ordinary observer himself to distinguish the one article from the other.

All that is necessary to effect the discrimination is to spread a few of the filaments out on a slip of glass, to moisten them with water, and after the lapse of a few minutes to note well the appearances presented by them.

Isinglass and gelatine differ, especially in the following characters:—

The shreds of *isinglass*, when immersed in cold water, become white, opaque, soft, and swollen.

The swelling is equal in all directions, so that, when viewed with a low power of the microscope, the shreds appear more or less quadrangular.

In boiling water, they dissolve nearly without residue.

The smell of the dissolved isinglass, when hot, is somewhat fishy, but not unpleasant.

The moistened shreds, or the solution, exhibit to test paper a neutral, or faintly alkaline, and rarely a slightly acid reaction.

Under the microscope, the filaments exhibit a well marked fibrous structure.

In acetic acid they swell up, and become soft and jelly-like, the greater part of the structure being lost.

Lastly, "The ash which results from the incineration of good Russian isinglass is of a *deep red* colour: it contains but a small portion of carbonate of lime, and never amounts to more than nine per cent. of the isinglass used." *

The shreds of *gelatine*, on the contrary, when placed in cold water, swell up, acquire increased transparency, and become translucent and glass-like.

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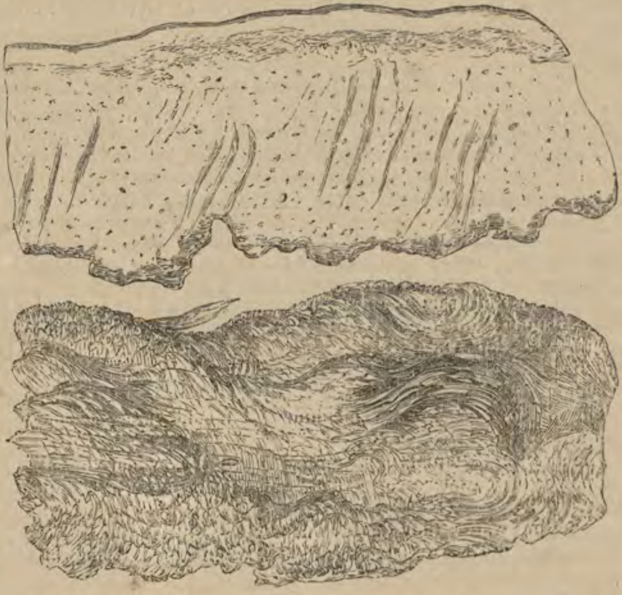
* Pharmaceutical Journal, vol. x. p. 127.

The form which the shreds take in swelling is peculiar: they do not, like those of isinglass, swell equally, and remain quadrilateral, but become expanded, flat, and ribbon-like, the broad surfaces corresponding to the incised margins.

Fig. 176.



Sections of shreds of GELATINE and ISINGLASS. Upper figure, *Gelatine;* lower, *Isinglass.* Magnified 75 diameters.

The dry shreds on the uncut surfaces frequently present a peculiar, shining lustre, not unlike that of tinsel.

In boiling water, they do not entirely dissolve, but in most cases a copious deposit falls to the bottom of the glass.

The smell of the hot infusion is like that of glue, and therefore disagreeable.

The moistened filaments, or the solution of gelatine, usually exhibit a strong acid reaction: this in some cases is due to the substances used in bleaching it.

They show no structure under the microscope, but only the marks of the instrument employed in cutting them.

Immersion in dilute acetic acid hardens gelatine.

Lastly, the ash is different from that of isinglass in amount, colour, and composition. "100 grains of gelatine give from 2·3 to 2·6 grains of ash, which is *white*, contains much carbonate of lime, with some chlorides and sulphates."—*Letheby.*

It is therefore very easy to distinguish between isinglass and gelatine, even when the shreds of the two articles are mixed together in the same parcel.

The discrimination is, however, much more difficult when they are both incorporated in the same shreds or strips; nevertheless, by means of the microscope, this adulteration, first described by Mr. Redwood, may frequently be discovered.

If, on examination with that instrument, the shreds, after immersion in cold water for a few minutes, exhibit a thick border of a clear and structureless substance, there is no doubt but that the shreds are coated with gelatine.

Some of the better kinds of Brazilian isinglass are manufactured in the same way as Russian, and sold at a cheaper rate. No doubt, in some instances, this is mixed with, or sold as the best, and it has been ascertained that acids and other chemicals have been used to improve its colour; but the test of good isinglass is in the jelly made therefrom.

The jelly made from Russian isinglass dissolves readily, furnishes scarcely any sediment, and is remarkably firm, pure, and translucent.

On the other hand, Brazilian isinglass makes a far inferior jelly, with these remarkable differences: that whilst Russian isinglass is firm, and free from deposit, Brazilian isinglass leaves a deposit of insoluble matter amounting to twenty or thirty per cent., is less readily dissolved, and the jelly is opalescent, and milky.

On making *blanc-mange* with the purest Russian isinglass, milk is needed to impart the snow-white colour of that jelly; but in the case of Brazilian isinglass, hot water alone will render it nearly of that colour. It is almost needless to add that the *blanc-mange* is much inferior in quality, and the large per-centage of insoluble matter renders the jelly proportionately weak.

The quality of any isinglass may easily be tested by dissolving a small portion in a glass vessel, with about a tablespoonful of boiling water. The best Russian isinglass will instantly dissolve, and scarcely a particle of sediment remain; the soluble matter in this article being, according to the best authorities, ninety-eight grains in every hundred.

The same test applied to Brazilian isinglass will extract the gelatine, but the shreds, from their fibrous character, do not entirely dissolve; they turn white and retain their form, unless disturbed, in which case they break up, and form a deposit at the bottom of the vessel.

If Russian isinglass be adulterated with Brazilian, the admixture may easily be detected by the insoluble shreds, or white deposit, which is sure to appear in proportion to the amount of Brazilian isinglass that may be introduced. The smell of the latter also is strong, far from pleasant, and forms a great contrast with the faint, inoffensive, seaweed-like odour of Russian isinglass.

Duty free. Importation in 1854, 1,881 cwts.; in 1855, 1,567 cwts.

GELATINE, AND ITS ADULTERATIONS.

As we are not acquainted with any trustworthy or practical account of the method of preparing gelatine, we have been at some pains to procure the following information respecting its manufacture.

Ordinary gelatines are made from those pieces of skins which are cut off by the tanner as unfit for making leather, in consequence of thickness. The best description is prepared from the skins of calves' heads; these are separated from the whole skins after they have passed through the process of liming, to remove the hair from them.

The skins are next well washed, to get rid of the lime, and all the pieces of flesh and fat are carefully cut out; some manufacturers soak them for a short time in a dilute solution of muriatic acid, to remove any remaining portion of lime; but this practice is both injurious and unprofitable. The acid forms with the lime chloride of calcium, which, if it is not carefully removed by washing, is boiled up with the skins, and, being soluble, remains in the gelatine; a portion of the skins is also dissolved by the acid, and is thrown away in the water employed in washing them, which thus occasions a loss in weight.

In some cases the skins are boiled whole, in others they are cut into small pieces, or even reduced to a pulp by a machine especially constructed for the purpose.

If the skins are cut into fine pieces, instead of being put into the boiler whole, the gelatine will be better; that is, it will be of a lighter colour; and the process is more economical, as one half the time will be saved in the boiling, and much less heat and fuel required. As the gelatine is darkened by prolonged boiling, the reduction of the skins to a pulp is a point of very great importance in the manufacture of gelatine—so much so, that Mr. Swinburne has obtained a patent for this method of preparation.

The skins are boiled with water, in the proportion of about one gallon of water to seven pounds of skin; a small quantity of common salt is added to preserve the gelatine. After it has boiled for about twelve hours, it is strained and clarified with white of eggs, and then run upon glass plates; as soon as it is solid, it is cut into slices and laid upon nets to dry, in a room heated to a temperature of about 80°. If the room is not heated, the surface of the gelatine becomes covered with small air-bubbles; when the gelatine is dry, it is cut by a machine in the same manner as isinglass.

The size of the glass plates varies according to the fancy of the manufacturer. The ordinary size is fifteen by eighteen inches; but in some cases they are three feet square; the plates or slices of gelatine are generally about fifteen inches long by three wide.

Though the skin of the head of the calf only is used for making gelatine, the whole of the skins both of the calf and ox are perfectly adapted for the purpose, but are not used, as they are much more valuable for conversion into leather.

In some cases, especially in warm weather, the skins used are somewhat decomposed, but this is not generally the case. This condition, although removed to some extent by repeated washings, cannot be entirely remedied; hence gelatine made from such damaged skins will always retain a smell and taste more or less disagreeable.

French gelatine is usually much whiter than English; this is owing principally to the calves being killed in France much younger than in this country.

Gelatine is likewise prepared from the bones of the ox and the sheep. It is obtained by boiling bones in water under pressure. It is more readily procured by employing bones which have been previously digested in hydrochloric acid to extract the phosphate of lime. "In this way a nutritious soup is prepared in Paris for the hospitals and other pauper habitations. Gelatine has been extracted from antediluvian bones. A soup was prepared from the bones of the great mastodon by a préfet of one of the departments of France."—*Pereira.*

In the "London Journal of Arts and Sciences," a publication which contains the specification of new patented inventions, we find the following description of a patent granted to George Philbrick Swinburne, of Pimlico:—

"The patentee commences his specification by stating that heretofore, in manufacturing gelatine, it has been usual (with one exception) to act on large pieces of hides or skins, and to employ acids and alkalies, together with mechanical and other processes, which occupy considerable time, and are likewise costly; and in the excepted case above referred to, it has been the practice to reduce the pieces of hide into the state of pulp in a paper machine, and then to employ blood to purify the product obtained.

"This invention consists in the following more simple mode of manufacturing gelatine. The patentee takes hides or skins, or parts thereof, as fresh and sweet as possible, and free from hair, and he reduces the whole into shavings or thin slices or films, by any suitable instrument; he soaks the shavings or films for about five or six hours in cold water, and then changes the same; he repeats such changing of the water two or three times each day, until no smell or taste is to be detected, either in the water or in the shavings, and then he removes the shavings from the water. If this product is intended for soup, it is dried on nets, and is then ready for use. If gelatine is to be extracted, the shavings, after the above soaking, are put into a suitable vessel, with a quantity of water, sufficient to cover them when pressed down, and they are subjected to a heat not exceeding boiling water. When dissolved, the gelatine is to be strained through linen or other fabric, subjected to slight pressure with the hands or otherwise, or the solution may be permitted to run off from the vessel without straining, by which means much of the gelatine will be separated from the fibrous matters. The product of gelatine thus obtained is run in thin films on to a smooth surface of slate, or other suitable material, to set; it is then removed on to nets to dry, and when dry it is cut up with an isinglass cutter or other suitable apparatus. The residue, dried or not, may be used for thickening soup, and other culinary purposes."

"Another manufacture of gelatinous substances is produced by the following process, from cod sounds, or other fishy matters capable of yielding gelatine:—These matters are reduced to shavings or thin films, soaked in water, subjected to the action of heat, and the gelatine strained or run off as above described. The patentee obtains a first, second, and third product of gelatine, which he forms into sheets, and when dry cuts up the same with an isinglass cutter. This manufacture of gelatine will be found highly useful as a cheap substitute for isinglass for clarifying liquids."

Inferior gelatine is used in large quantities by paper makers, straw-hat and silk manufacturers; but these parties generally purchase the skins, and prepare the gelatine themselves.

Unlike isinglass, the shreds of gelatine, as already noticed, examined with the microscope, are seen to be composed of a transparent and perfectly homogeneous substance. See *fig.* 176.

Glue is quite a distinct manufacture from gelatine, and is seldom carried on by the same parties. It is made from bones, refuse pieces of skins, and hoofs.

ON THE ADULTERATIONS OF GELATINE.

The addition of a small quantity of salt, with the view of ensuring the preservation of the gelatine, is, of course, allowable; but *salt* is frequently added in large quantities: it then causes the gelatine to absorb moisture from the atmosphere, whereby its weight is much increased.

In some cases, gelatine is adulterated with *sugar*, either brown or white, not to any considerable extent, except with some of the inferior qualities, such as are so largely used by the manufacturers of canister meats.

The jellies in bottles, and those sold by confectioners as isinglass and calves' feet jelly, consist principally of gelatine variously flavoured. Jellies made from calves' feet are much less firm, and dissolve quicker than those made from gelatine, if kept in a warm room.

On the Detection of the Adulterations of Gelatine.

The adulteration of gelatine with *salt* may be thus detected: — 200 grains of the gelatine must be incinerated and the ash tasted for salt; the quantity of which present may be determined, if necessary, by the process given under Annatto.

For the detection of the *sugar* the following process may be followed: — Dissolve the gelatine in water; precipitate with tannic acid; filter, and evaporate the solution to dryness, when the sugar will be found in the residue.

A better method is the following: — Soften the gelatine by maceration in a little water, boil in alcohol; this will take up the sugar and leave the gelatine.

Gelatine is free of duty on importation, and is largely manufactured in this country.

ANNATTO, AND ITS ADULTERATIONS.

THE next article which falls under our consideration is annatto; this, though not employed as food, is yet added to several articles of consumption, and it therefore becomes of interest to ascertain whether it is subject to adulteration or not.

Annatto is the colouring matter obtained from the seeds of a plant named *Bixa orellana*, L., and which forms the type of the small natural order *Bixineæ*. It is a native of South America, the West and East Indies; but the article annatto is chiefly prepared in Brazil and Cayenne.

The tree is an evergreen, and the seeds are enclosed in pods, the colouring matter being situated on the outside of the seeds.

It appears that two different processes are pursued in order to separate the colouring matter. According to the ordinary process, the seeds, after being removed from the pods, are bruised, transferred to a vat, when they are mixed with as much water as covers them. Here they are left for several weeks or months. "The substance thus obtained," Dr. Ure states, "is now squeezed through sieves, placed above the steeper, that the water containing the colouring matter in suspension may return into the vat.

"The residuum is preserved under the leaves of the Annana (pine-apple tree) till it becomes hot by fermentation. It is then again subjected to the same operation, and this treatment is continued until no more colour remains.

"The substance thus extracted is passed through sieves, in order to separate the remainder of the seeds; and the colour is allowed to subside. The precipitate is boiled in coppers until it is reduced to a consistent paste. It is then suffered to cool, and is dried in the shade."

The second process is that recommended by Leblond. He proposes simply to wash the seeds until they are entirely deprived of colour, to precipitate the colouring matter by means of vinegar or lemon juice, and to boil it up in the ordinary manner, or to drain it in bags, as is practised with indigo. The annatto prepared in this way is said to be four times as valuable as that made according to the first-described process.

It does not appear from either of these descriptions that anything is added to the annatto except water. This is important with reference to its adulteration.

Before proceeding to enter upon the question of the adulteration of any article, the first step necessary is to make oneself acquainted with its properties and characteristics; and if the substance be vegetable, it is requisite that we should determine its structure by means of the microscope. We thus obtain certain fixed data or standards of comparison from which to start.

Structure of the Seed of Annatto.

Subjecting the seeds of annatto to examination with the microscope, we find that their outer or red portion does not exhibit any very definite structure, that the surface of the seed proper consists of narrow or elongated cells or fibres, vertically disposed; while the inner white portion consists of cells filled with numerous starch corpuscles, well defined, of medium size, and resembling in form and in the elongated and stellate hilum the starch granules of the pea and bean. *Fig.* 177.

In *genuine* manufactured annatto but little structure is met with; portions of the outer cells are however seen, as well as, in those specimens which in the course of their preparation have not been subjected, as they usually are, to the action of boiling water, a few of the starch corpuscles.

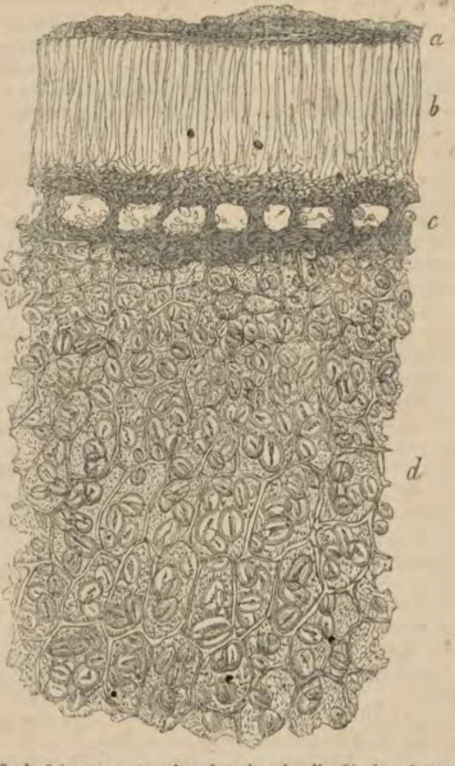
Annatto is used by dyers, painters, soap makers, and to colour milk, butter, and cheese.

By dyers and soap makers it is frequently purchased for use in the state in which it is imported, these parties adding the alkali as a solvent as they use it; in these cases it does not pass through the hands of the English so-called manufacturers at all. In other cases the manufacturers re-prepare it in the several forms of roll, cake, orange, black, and fluid annattos.

Composition of Annatto.

The pulp surrounding the unfermented fresh seeds was found by Dr. John to consist of 28 parts of colouring resinous matter, 26·5 of vegetable gluten, 20 of ligneous fibre, 20 of colouring, extractive matter 4, formed of matters analogous to vegetable gluten and extractive, and a trace of spicy and acid matters.

Fig. 177.



Section of Seed of ANNATTO. *a, coloured portion; b,* cells of *husk; c,* layers of cells situated between the husk and seed proper; *d,* cells of *seed* proper containing *starch corpuscles.*

The colouring matter is soluble in water, but more so in alcohol and alkalies. The latter change its colour somewhat from red to orange. When annatto is used as a dye, it is cut in pieces and boiled in a copper with crude pearl ashes.

On subjecting the seeds of annatto to examination, we obtained an ash which weighed 4·80 grains per cent., and which was nearly white, with here and there a faint tinge indicating the presence of a mere trace of iron: it yielded ·20 of a grain per cent. of alumina, tinged only very slightly with iron.

The red or outer part of the seeds yielded on examination nearly similar results.

These results may, therefore, as we shall see more fully hereafter, be taken as representing to some extent the proper weight of the ash of genuine annatto, and of the iron and alumina which it usually contains.

ON THE ADULTERATIONS OF ANNATTO.

There is scarcely an article with which we are acquainted subjected to so large an amount of adulteration, and this of the grossest possible description, as annatto.

The substances employed are various, some of them being organic and others inorganic.

The *organic* adulterations which we ourselves have detected, are those with *turmeric*, *rye*, *barley*, and *wheat* flours.

The *inorganic* adulterations observed by us are as follow: with *sulphate of lime*, *carbonate of lime*, *salt*, *alkali*, *an oily substance*, probably soap, red ferruginous earths, mostly *Venetian red*, *red lead*, and *copper*.

The employment of large quantities of flour and of lime so reduces the colour of the annatto that it becomes necessary to have recourse to salt, alkalies, and the red earths, to restore it to something approaching its natural standard.

The effect of salt in heightening the intensity of vegetable reds is well known, and hence its use.

The lead detected was probably introduced into the annatto through the Venetian red used.

At first we were disposed to regard the copper in annatto as an accidental impurity: there is good reason for believing that it is purposely added to prevent the annatto from becoming attacked with fungi, and to which it is so prone, in consequence especially of its admixture with such large quantities of flour and salt. The salt by attracting moisture, hastens the decomposition of the flour.

Results of the Examination of Samples.

The following results were obtained from the examination of *Thirty-four* samples of *annatto* of all kinds *as imported*, as obtained from *English manufacturers*, and as purchased from *dealers*:—

1st. That of the thirty-four samples of annatto of all kinds examined, *two only were genuine*, and were entirely free from adulteration; these being two red cake annattos as imported.

2nd. That the whole of the remaining samples consisted of *mixtures in various proportions of one or more substances, these amounting in many cases to one-half, and in some instanes to even two-thirds of the entire specimens.*

3rd. That of the two samples of *Black Annatto*, obtained from manufacturers, one furnished a highly ferruginous *ash*, which was very alkaline, which amounted to 32·50 per cent., and which consisted of an *alkali*, some *chalk*, and *a red ferruginous earth;* while the second yielded an *ash* that weighed 35·36 per cent., which was still more ferruginous, and which consisted of *alkali* and *some red earth.*

4th. That of the four samples of *Orange Cake Annatto*, obtained from manufacturers, one furnished an *ash* which amounted to 62·00 per cent., and which consisted chiefly of *chalk*, with a trace of *lead:* the *ash* of the second sample weighed 57·72 grains per cent., and also consisted principally of *chalk;* the third sample contained a large quantity of *turmeric* and a little *wheat flour;* the *ash* amounted to 44·4 per cent., and consisted of *chalk* and some *red earth;* while the *ash* of the fourth sample weighed 63·00 per cent., and was composed chiefly of *chalk.*

5th. That of the two samples of *Red Cake Annatto*, procured from manufacturers, one contained a very large quantity of *wheat flour*, and yielded 17·12 per cent. of *ash*, which consisted of *salt* and some *red earth;* the other also contained a very large quantity of *wheat flour*, and furnished 14·26 per cent. of *ash*, consisting chiefly of *salt* and some *ferruginous earthy colouring matter.*

6th. That of the five samples of *Orange Cake Annattos*, purchased of different retail dealers, one yielded 57·80 per cent. of *ash*, which consisted principally of *chalk;* a second contained a very large quantity of *turmeric*, and gave an *ash* which weighed 36·56 per cent., and which was composed of *chalk* and a *red ferruginous earth;* the third contained the starch of *sago*, the *ash* weighing 58·46 per cent., which was composed chiefly of *chalk;* the fourth contained a very large quantity of *turmeric*, and yielded 40·30 per cent. of *ash*, composed of *chalk, ferruginous earth*, and a little *salt;* while the fifth gave 59·12 per cent. of *ash*, which consisted principally of *chalk* with traces of *lead.*

7th. That the samples of *Red Roll Annatto* nearly all contained large quantities of either *wheat*, *barley*, or *rye flour*—usually the latter, to the extent of 30 and even over 40 per cent.; much *salt* and some *red ferruginous earth*, as *Venetian red*, *red ochre*, or *reddle.*

Reviewing then the results of the microscopical and chemical examination of the thirty-four samples of annatto, it appears that large quantities of *turmeric* were present in three samples, *wheat* or *barley flour* in four, and *rye flour* in nine; the majority of these samples containing full forty per cent. of flour; that *chalk* was present in a great many cases, frequently to the extent of fifty and even over sixty per cent., *sulphate of lime* in at least five cases, a *red ferruginous earth* in a great many, an *alkali* in several, *salt* in many, *lead* in five cases, and *copper* in at least four samples.

The *iron* and *alumina* amounted in some cases to near three and even over five per cent. Had all the samples been examined qualitatively for iron, it is probable that still larger amounts would have been met with, as the worst cases were not specially selected for examination.

In two of the five samples in which *lead* was detected, the quantity was not weighed, and is described as *traces* only, while in the other three samples the quantities amounted to ·30, ·50, and to 1·20 per cent.

My friend, Mr. Hogg, the author of the "Treatise on the Microscope," himself procured some samples of annatto, and found them to be adulterated with *rye* and *barley* flours, *turmeric*, *salt*, *red earth*, and *carbonate of lime*.

Lastly, the following analyses by Dr. Bernays embody the results of the chemical examination of the ashes of five samples of annatto furnished him by the author.

No. 1.

Ash of 100 grains, weighed 62·40, which was composed of —

Carbonate of lime	37·88
Sulphate of lime	8·82
Alkaline sulphates	4·34
Chloride of sodium	6·42
Iron and alumina	2·14
Lead, traces, sand, &c.	2·80
	62·40

No. 2.

Ash of 100 grains, weighed 13·70 : —

Chloride of sodium	6·87
Sulphate of lime	4·12
Iron and alumina	1·40
Sand, &c.	1·31
	13·70

No. 3.

Ash of 100 grains, weighed 17·20 : —

Chloride of sodium	9·30
Sulphate of lime	4·00
Iron and alumina	·90
Sand, &c.	3·00
	17·20

No. 4.

Ash of 100 grains, weighed 13·95 : —

Chloride of sodium	4·31
Sulphate of lime	5·92
Iron and alumina	1·32
Sand, &c.	2·40
	13·95

No. 5.

Ash of 100 grains, weighed 62·26 : —

Carbonate of lime	42·00
Sulphate of lime	8·84
Chloride of sodium	6 56
Iron and alumina	3·20
Sand, &c.	1·66
	62·26

The presence of *lead* in annatto has been detected, not only by ourselves, but by Accum, Mitchell, Bernays, and Normandy.

Accum, at page 276. of his "Treatise," has written to this effect: — "Several instances have come under my knowledge in which Gloucester cheese has been contaminated with red lead, and has produced serious consequences on being taken into the stomach. In one poisonous sample which it fell to my lot to examine, the evil had been caused by the sophistication of the annatto employed for colouring cheese. This substance was found to contain a portion of red lead." Accum then goes on to quote the particulars of a case recorded by a Mr. Wright, of Cambridge: — A gentleman, after partaking of some toasted cheese at an inn on two different occasions, was both times made ill by it. The matter was referred to the manufacturer of the cheese, who, on inquiry, ascertained that the annatto which had been used to colour the cheese was itself coloured or adulterated with both vermilion and red lead.

Mr. Mitchell, in his "Treatise on the Falsification of Food," published of 1848, states, page 231: — "I have frequently examined specimens in annatto which have been contaminated with red lead, or a mixture of red lead or ochre."

Lastly, Dr. Normandy, in his "Commercial Handbook of Chemical Analysis," writes, "Unfortunately as it, annatto, is very often adulterated with red lead, or with both red lead and ochre, the use of such annatto is very injurious, and serious accidents have been caused thereby."

Two of the authors quoted, viz., Accum and Mitchell, testify to the fact of the presence of lead in annatto and cheese of their own knowledge. It is not clear whether Dr. Normandy does so or not, or whether he merely repeats the statements of others on the subject. Now there is no evading the evidence of the first two witnesses.

We would further observe, that in some of the samples examined the ingredients were so badly mixed, that in some instances we picked out specks or masses of the substances added, as of the different kinds of flour used, turmeric, chalk, and red earth.

Now the manufacturers of annatto will doubtless try to persuade us, and perhaps others who are not manufacturers will do so as well, that some of the substances which we have mentioned are introduced to improve the article, to render it more soluble, and to make it keep better. We are ready to admit that the use of alkali is perfectly justifiable to render it more soluble, but beyond this we do not go; and allowing this plea of improvement to have all the weight that can possibly belong to it, enough will still remain to show that annatto is subject to a large amount of adulteration, for it is impossible to justify the use of turmeric, of Venetian red, or reddle, of 40 or 50 per cent. of wheat, barley, or rye flour, and of 50 and over 60 per cent. of chalk and sulphate of lime.

With respect to the plea, which may possibly be urged, that some of the substances added make it keep better, we would remark, that annatto, with ordinary care, will keep perfectly well for months and years without any such addition, and that the substances added are not always effectual. It often remains in the docks before it is sold for one or two years, during which long period it retains its goodness. Thus, while we have never seen a sample of annatto as imported attacked with maggots, several of those which we have purchased at shops were so; and in consequence of the large quantity of salt which they contained, they attracted water to such an extent, that they quickly became spoiled. One specimen, which was riddled through with holes, yielded an ash which weighed 12 per cent., and it contained lead and iron. Another sample, one of those sent by Mr. Hogg, was infested with living larvæ, and yet this contained a large quantity of turmeric powder, starch, salt, and a red earth—the ash amounting to 24 per cent., and yielding 1·70 per cent. of iron and alumina, as red as reddle.

Some of the samples examined did not contain more than 30 per cent. of annatto; and could it be shown that the reduction of annatto to this enormous extent was justifiable — which, however, it certainly is not — then it cannot be denied it is high time that the name of annatto should be abandoned, and that some name or names should be adopted which would express the actual composition of the article, and serve to indicate the fact that the article thus reduced consists in part only, and that often the smallest part, of that which it professes to be —viz., annatto.

Mr. Wakley, who gave some highly interesting and important information, in regard to adulteration, before the Parliamentary Committee, communicated the following evidence respecting the annatto sent out by a house to which he was attached in early life:—"It consisted of flag annatto half a pound, powdered turmeric three ounces, powdered lime three ounces, and soft soap ten ounces. But frequently, when there was no flag annatto to be had, an additional quantity of turmeric was put in, with some red colour which I do not now recollect; but often it was sent out without a particle of annatto. The powder for moulding the annatto consisted of eight ounces of whiting and two ounces of Dutch pink."

We have now advanced enough to prove that annatto is extensively and scandalously adulterated.

At the meeting of the Pharmaceutical Society, to which the author's paper on the adulteration of annatto was communicated, Mr. Theophilus Redwood, whose views in regard to conventional adulterations, &c., have excited so much surprise, undertook the Quixotic task of proving that the various substances found in adulterated annatto were all added to improve the article, Mr. Redwood not even objecting to the sulphate of copper found.

Amongst the evidence given before the Parliamentary Committee in defence of adulteration, excepting only that of Mr. Redwood, none was more remarkable for extraordinary assertion than that of Mr. Drew, of the firm of Drew, Heyward, and Barron, wholesale druggists. The few following particulars will serve to show the character of Mr. Drew's evidence:—

He denied that annatto was adulterated, on the ground that it was physically impossible to mix turmeric with annatto, the fact being that nothing is more easy.

In like manner he denied that cinnamon was adulterated, and alleged that cassia was as dear as cinnamon; also that arrowroot was not adulterated, since sago and potato powders were worth as much; and lastly, he flatly denied that spices were adulterated in any degree, these assertions being unsupported by a particle of proof.

We now come to make a few remarks on the employment of annatto in the colouring of milk, butter, but principally cheese. We would first state that we do not apprehend that danger, we will not say ever, is often likely to arise from the occasional presence of lead in annatto, seeing that the quantity used to colour cheese is but small.

The practice of colouring cheese with annatto entails, however, some expense and trouble, while it serves no really useful purpose, and on these grounds it is to be condemned; but on this point we will cite the opinions of two well-known authorities on dairy farming.

In the "Rural Cyclopædia," part i. p. 127. we find, amongst other remarks relating to annatto, the following:—"Another variety of annatto that is commonly employed in English dairies, is manufactured in Brazil into small rolls, each two or three ounces in weight, hard, dry, and compact; brownish without, and red within. But its grand interest to the farmer consists in its very extensive use as a colouring matter for butter, and especially cheese. The cheese makers of Gloucestershire give one ounce of annatto to one hundredweight of cheese, and those of Cheshire eight dwts. to sixty pounds. But as these quantities are far too small to medicate the cheese, or even to affect its flavour, the only advantage to be derived from the annatto is mere colour, and surely the appearance of Stilton or Dunlop cheese upon the table is to the full as agreeable as that of Gloucestershire or Cheshire cheese. The use of annatto, therefore, is sheerly whimsical, imposing perfectly useless trouble on the manufacturer, and some small ridiculous expense upon the purchaser. The mode of using it is to dissolve it in the hot milk immediately before churning."

Mr. Stephens, in his "Book of the Farm," part iii. p. 288., makes some observations on the use of annatto to colour cheese, nearly to the same effect. He says:—"I have not recommended the use of annotto, or arnotto, for dyeing cheese, because I think by it the cheese farmers impose upon themselves a very useless piece of trouble. All the quantity employed is said to impart no peculiar flavour to the cheese; which being acknowledged, of what utility is it? As for improving the appearance of cheese, I suppose it will not be denied that

Stilton and Dunlop cheese look as well upon the table as Gloucester and Cheshire cheese."

On the Detection of the Adulterations of Annatto.

Annatto in the manufactured state presenting so few evidences of structure, it is a very easy matter indeed, by means of the microscope, to detect the presence in it of most foreign vegetable substances, as *turmeric powder*, and the *starch* of *wheat*, *rye*, *barley*, and *sago flours*.

The turmeric, owing to the action of the salt and alkali usually present with it in the annatto, is generally much changed; most of the colouring matter of the cells is discharged, so that the starch corpuscles contained within them become visible; loose starch granules of turmeric may also be frequently seen presenting their usual characters, except that they are much increased in size in consequence of the action of the alkali upon them. *Fig.* 178.

The characters of turmeric powder will be found described at p. 387., of wheat at p. 243., of rye at p. 246., of barley at p. 246, and of sago starch at p. 324.

The presence of most of the *inorganic adulterations* is in many cases sufficiently manifest by the appearance, weight, and taste of the ash. Thus the weight of the ash generally serves to show the presence of sulphate and carbonate of lime; the colour, the presence of the red earths; and the taste, the salt and alkali: the presence of salt can indeed generally be ascertained by the taste of the annatto itself. Sometimes, however, a quantitative examination is required.

The inorganic substances for which annatto has to be tested chemically are *sulphate* and *carbonate of lime*, *carbonate of potash*, *chloride of sodium*, *red ferruginous earths*, *lead*, and *copper*.

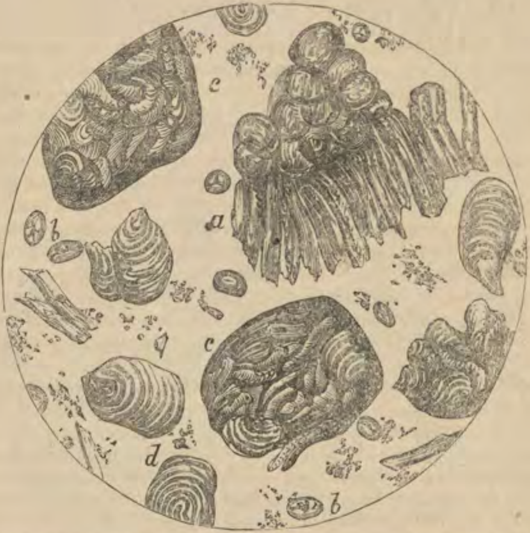
As several of these substances sometimes occur in the same samples, we shall not describe the processes for the detection of each of the substances met with separately, but in the form of a combined analysis.

Incinerate 100 grains of the annatto, weigh the ash, pulverise; treat with about half an ounce of distilled water: this will separate the chloride of sodium and the carbonate of soda or potash, should either of these be present; and the quantities of which may be estimated as follows:—

Divide the solution into two parts; precipitate from one the chlorine of the salt by means of nitrate of silver, and calculate the chloride of silver formed into chloride of sodium. Evaporate the other portion of the solution nearly to dryness, treat with a little hydrochloric acid, dilute with a small quantity of water, and proceed in the estimation of the carbonate of soda or potash in the manner indicated in the article on Turmeric.

Boil the portion of the ash insoluble in water in as small a quantity as possible of pure but dilute nitro-hydrochloric acid: dilute with water, filter; weigh the residue insoluble in the acids, and deduct it from the gross weight of the ash: it will consist of silica, sand, and some unburned carbon.

Fig. 178.



ANNATTO adulterated with *turmeric*. Magnified 225 diameters. *a*, outer part of seed; *b*, starch granules; *c c*, cells of turmeric; *d d*, free starch granules of same, but much altered by the action of the alkali.

Divide the solution into two parts from one; throw down the sulphuric acid, if present, by means of nitrate of baryta; collect, wash, ignite, and weigh: from the other precipitate the lime with oxalate of ammonia: calculate the sulphuric acid into sulphate of lime: if there is any excess of lime, calculate it into carbonate of lime.

We have now only to estimate the *alumina* and *iron*, *lead*, and *copper*.

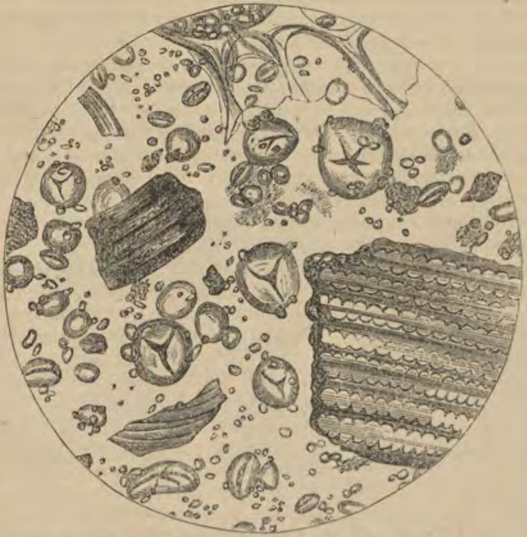
For the determination of these it is best to operate upon another portion of ash: dissolve with heat in *dilute* nitric acid, evaporate nearly to dryness, dilute with water, and divide the solution into two portions.

Estimate the iron and alumina in one portion, separating them from the phosphates in the manner directed under the article Chicory at p. 149.

In the other, estimate the copper and lead quantitatively as follows:—

Separate the lead from the copper by means of pure dilute sulphuric acid, added in slight excess: the precipitate must be washed first with water acidulated with sulphuric acid, and finally with spirits of wine; dry, ignite, and weigh.

Fig. 179.



ANNATTO adulterated with *rye flour*. Magnified 225 diameters.

Precipitate the copper by means of sulphuretted hydrogen; collect, dry, weigh, and calculate into the sulphate.

Or the following process may be adopted for the separation of the lead:—Mix the concentrated nitric-acid solution with hydrochloric acid in excess; add a large quantity of absolute alcohol mixed with some ether; let the precipitate subside, filter the fluid off, wash the precipitate with alcohol and ether, dry it, and expose it to a gentle heat.

The following process for detecting and estimating minute quantities of oxide of copper, is by Mr. Warington:—

"This operation depends upon the solubility of the ferrocyanide of copper in an excess of a solution of ammonia, and its deposition with its well-marked characteristic appearances as the ammonia evaporates.

Thus, supposing a frequently occurring case, where the oxide of copper, in very small quantity, is in solution with oxide of iron, and that these metals have been brought to their highest state of oxidation; ammonia is next added in excess, and then a few drops of a solution of the ferrocyanide of potassium, and the whole thrown upon a filter. As the ammonia escapes from the filtrate by standing, and free exposure to the air, the red ferrocyanide of copper will be deposited, and if the experiment be made in a shallow white porcelain dish, the result will be very distinct and characteristic, and on carefully decanting the fluid, will be found on the white surface. In many cases, the process of filtration may be dispensed with altogether, as the suspended peroxide of iron does not in the least interfere with the deposition of the ferrocyanide of copper from the solution. I have found this test give unerring indications in cases where no trace of blue colour could be distinguished in the ammoniacal solution, and where no precipitation could be procured by hydrosulphuric acid gas or the action of a voltaic circuit.

"When organic colouring matter is present, this form of test is also very useful, as in vinegars, &c."

Annatto is free of duty on importation. Quantities imported in 1854, 4,371 cwts., value 25,418*l.*; in 1855, 2,966 cwts., value 14,765*l.*

Further particulars in regard to the adulteration of annatto will be found in the author's paper published in the "Pharmaceutical Journal" for January, 1856.

CHEESE, AND ITS ADULTERATIONS.

Cheese consists of the curd of milk, freed from whey to a certain extent, and ripened by keeping.

The curd is usually precipitated from milk by means of a solution of rennet, which is prepared from the dried stomach of the calf and sometimes the pig.

It may be precipitated by means of acids, but these are rarely if ever employed in this country in the making of cheese; also by several other substances, as pure curd, old cheese, the natural fluids of the stomach, the first extract of malt and sour leaven. Professor Johnston particularly recommends trials to be made of the pure prepared curd:—"If," he remarks, "we are able to rescue the manufacture of rennet out of the mysterious and empirical hands of the skilled dairymaid, and by the use of a simple, abundant, easily prepared, and pure rennet, can command at once a ready coagulation of the milk, and a curd naturally sweet, or of a flavour which we had foreseen and commended, we should have made a considerable step towards the perfection of the art of cheese making."*

Curd for rennet may be prepared in the following manner:—"Heat a quantity of milk which has stood for five or six hours, let it cool, and separate the cream completely. Add now to the milk a little vinegar, and heat it gently. The whole will coagulate, and the curd will separate. Pour off the whey, and wash the curd well by kneading it with repeated portions of water. When pressed and dried, this will be casein sufficiently pure for ordinary purposes. It may be made still more pure by dissolving it in a weak solution of carbonate of soda, allowing the solution to stand for twelve hours in a shallow vessel, separating any cream that may rise to the surface, again throwing down the curd by vinegar, washing it frequently, and occasionally boiling it with pure water. By repeating the process three or four times it may be obtained almost entirely free from the fatty and saline matters of the milk."†

The following is the *modus operandi* of rennet: it promotes the conversion of the sugar of milk into lactic acid, which, acting like other acids, occasions the precipitation of the curd.

It has been objected to rennet that by it a readily fermentable and decomposable substance is introduced into the cheese, frequently causing it to pass into a state of decomposition.

It has been also objected to rennet that the stomachs from which it is prepared are often in a dirty and more or less decayed condition, and that the strength of the rennet made is very uncertain.

In order to obviate these latter objections the preparation of a solution of rennet, of standard and ascertained strength, has been suggested; salt, saltpetre, and such other additions being made to it as would ensure its preservation. Such a solution would appear to possess several advantages.

The proportions of caseine and butter in cheese vary with the kind of milk from which the cheese is made; thus *skim milk* cheese is much poorer in butter than other cheeses made from *whole milk.*

Cheshire cheese is of course made from whole milk; Stilton from cream; while cream cheese consists of the fresh curd of whole milk.

The salting of cheese may be effected in several ways: the salt may be added direct to the fresh curd, and this is the method usually practised in Scotland; or the newly made cheese may be immersed in a solution of brine; or the surface may be rubbed with dry salt—these methods are practised in Cheshire; or, lastly, the salt may be added to the milk previous to the precipitation of the curd. By this method the curd is very equally salted, but the quantity of salt required is very large, the greater part of it being retained in the whey.

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* Johnston's Lectures on Agricultural Chemistry, 2nd edit. p. 969.

† Transactions of the Highland Agricultural Society, July, 1847, p. 65.

On the Adulterations of Cheese.

We referred in the preceding article to the practice of colouring cheese with *annatto*,—a practice which we have shown to be useless, to entail some unnecessary expense, and, in consequence of the adulteration of annatto with injurious substances, to be attended in some cases with risk to health.

Other colouring matters are, however, sometimes employed for the same purpose as annatto; namely, *mangold flowers*, *saffron*, and the juice of red *carrots;* but most of the paler coloured and all the high coloured cheeses derive the whole of their colour from annatto. Stilton and Cheddar cheese are never coloured in any way.

It may be objected to the whole of these substances that their employment serves no useful purpose.

Various articles are likewise added to cheese to flavour it, and to impart a green or diversified colour.

"In some dairies, the leaves of sage, parsley, and other herbs, are infused into cheese to give it a green colour. In other dairies part of the curd, when ready for the press, is exposed in a sieve to the air, in order that it may become oxygenated, and may render the cheese, into which it is mixed with newly prepared curd, of a diversified colour, and of a disposition to run speedily into putridity. In a few dairies rapid putridity is induced by an intermixture of beaten potatoes. In Ross-shire, cheeses are for several days buried within seamark, in order that they may acquire a blue colour and a peculiar taste; and in France, a considerable quantity of cheese receives an offensive smell, resembling that of a pigstye, from the intermixture of fenugreek."*

Cheese is made from potatoes in Thuringia and Saxony, in this manner:—"After having collected a quantity of potatoes of good quality, giving the preference to a large white kind, they are boiled in a cauldron, and after becoming cool, they are peeled and reduced to a pulp, either by means of a grater or mortar. To five pounds of this pulp, which ought to be as equal as possible, is added one pound of sour milk, and the necessary quantity of salt. The whole is kneaded together, and the mixture covered up and allowed to lie for three or four days according to the season. At the end of this time it is kneaded anew, and the cheeses are placed in little baskets, when the superfluous moisture escapes. They are then allowed to dry in the shade, and placed in layers in large vessels, where they must remain for fifteen days. The older these cheeses are, the more their quality improves. Three kinds of them are made. The first, which is the most common, is made according to the proportions just given; the second, with four parts of potatoes and two parts of curdled milk; the third, with two parts of potatoes and four parts of cow or ewe milk. These cheeses have this advantage over other kinds, that they do not engender worms, and keep fresh for a number of years, provided they are placed in a dry situation and in well-closed vessels." *

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* Rural Cyclopædia, part iv. p. 778. art. Cheese.

Results of the Examination of Samples.

Twenty samples of cheese were subjected to analysis with the following results: —

All were artificially coloured, in most cases *with annatto.*

In none was *lead* present.

Several were coloured, on the outside, with *Venetian red* or *reddle* ground up into a paste with *grease.*

In none of the cheeses *was any substance*, either *organic or mineral present*, added for the purpose of increasing the bulk and weight of the cheese.

These results are so far satisfactory, especially as respects lead.

It must not be concluded, however, from the results of these twenty examinations, that lead derived from the adulterated annatto employed to colour the cheese is never present. If it occur only in one sample out of a hundred, much mischief would result in some cases.

That it does sometimes occur in both annatto and cheese is proved by the evidence of Accum and Mitchell.

Accum, at page 276. of his "Treatise," affirms that several instances had come under his knowledge in which Gloucester cheese had been contaminated with red lead, and had produced serious consequences on being taken into the stomach. In some of these cases it was ascertained that the annatto which had been used to colour the cheese was itself coloured or adulterated with both vermilion and red lead. See p. 471.

Mitchell writes, "I have only met with cheese that contained lead on one occasion, although it may be comparatively common."

The practice of coating cheese with Venetian red and reddle is even more objectionable than the use of adulterated annatto, since, should this contain lead in any case, and since some persons are thoughtless enough to eat the rind, the quantity of that metal consumed would be more considerable.

Although cheese escapes for the most part the hands of the adulterator, it does not escape the attacks of fungi, animalcules, and insects; to these it is particularly prone, in consequence of its being so very rich in nitrogen.

The green colour of mouldy cheese is due to the development of a small production or fungus, the common *Penicilium glaucum.*

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* Quarterly Journal of Agriculture, vol. ix. p. 310.; Book of the Farm, part iii. p. 296.

This mouldiness may be produced in comparatively new cheese by inoculation.

This is sometimes effected by inserting into the new cheese rolls of mouldy cheese, extracted by the scoop, into holes previously made by the same scoop.

It is said that large pins are often thrust into cheeses, and allowed to remain in them for a considerable time in order to produce the mouldiness. This is a very objectionable proceeding, as in this case the colour is due partly to the formation of a salt of copper, and partly in some cases to the development of the fungus, which takes place in consequence of the admission of air into the interior of the cheese.

At a still further period of decay cheese is attacked by the well known cheese mite or acarus, *Acarus siro* of Linnæus, and which is so small that it is scarcely perceptible without the aid of the microscope; *the dry and powdery parts of cheese consist almost entirely of these acari and their ova in different stages of growth. Fig.* 180.

"We often wonder how the cheese mite is at hand to attack a cheese wherever deposited; but when we learn from Leewenhoek that one lived eleven weeks gummed on its back to the point of a needle without food, our wonder is diminished," remark Kirby and Spence. Both these cheese maggots and mites, when numerous, destroy cheese rapidly, by crumbling it into small pieces, and by emitting a liquid substance, which causes the decayed parts to spread speedily. They may easily be killed, however, by exposure to strong heat, or by plunging the cheese in some liquid, such as *whiskey, capable of* destroying the larvæ without *communicating any disagreeable flavour.**

Besides the casualties *from fermentation, cheese, when yet quite fresh,* is subject to the attack of the cheese-fly (*Piophila casei*). The fly is ready to deposit its eggs in the deepest crack it can find, by means of an extensile abdominal tube. The specific distinguishing characters of this insect, as drawn up by Mr. Duncan, are as follow:—"About two lines in length, the whole body of a greenish-black colour, smooth and shining; front of the head reddish-yellow, paler yellow on the under side. Thighs ochre-yellow at the base and apex; tibia deep ochre, the first and last pair black at the apex; anterior tarsi black, the others ochrey, with the two last joints and the claws black; wings clear and iridescent, slightly tinged with rust colour at the base, halteres ochrey."†

The cheese maggots produced from this fly are as large as the fly, and commonly called *jumpers.* "When this maggot prepares to leap, it first erects itself on its anus, and then bending itself into a circle, by bringing its head to its tail, it pushes forth its unguiform mandibles, and fixes them in two cavities in its anal tubercles. All being thus prepared, it next contracts its body into an oblong, so that the two halves are parallel to each other. This done, it lets go its hold with so violent a jerk, that the sound produced by its mandibles can be easily heard, and the leap takes place. Swammerdam saw one whose length did not exceed the fourth part of an inch, jump in this manner out of a box six inches deep, which is as if a man six feet high

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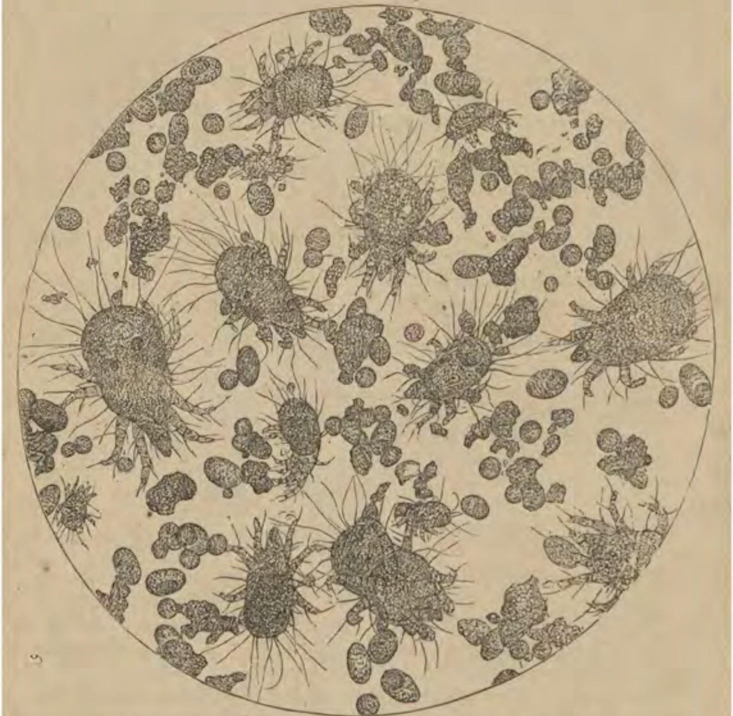
* Book of the Farm, part iii. p. 298.

† Kirby and Spence's Introduction to Entomology, vol. ii. p. 283.

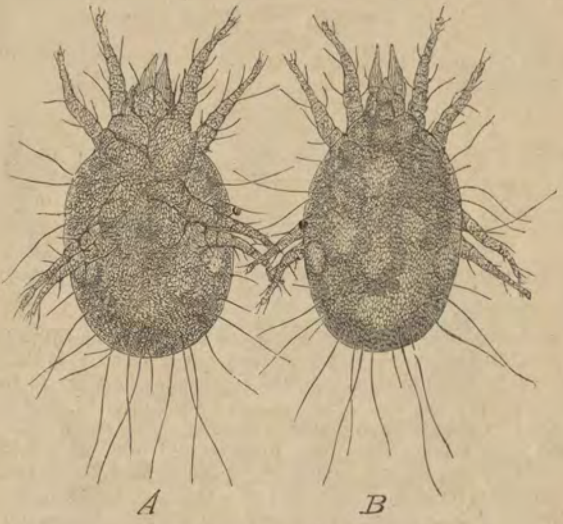
Fig. 180.



Dust of old Cheese, magnified about 40 diameters, composed entirely of *Acarus Siro* or *Cheese Mite*, in all conditions of development from the ova upwards.

should raise himself in the air by jumping 144 feet! He had seen others leap a great deal higher.*

Fig. 181.



Anterior and posterior views of *Cheese Mite*. Magnified 40 diameters.

On the Detection of the Adulterations of Cheese.

There is but little to be said under this head, since cheese is subject to so few adulterations.

The presence of annatto is sufficiently indicated by the colour, very obvious in most cheese, particularly when this is compared with an uncoloured cheese, such as Stilton.

In order to ascertain whether a cheese is adulterated or not, it should be examined both microscopically and chemically. By the microscope we shall be enabled to determine whether it contains starch, potato, or any other organic substance; and by chemistry, whether lead, iron, or any other mineral substance is present. When the cheese is coated with Venetian red, this should be separately examined for lead.

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* Book of the Farm, part iii. p. 297.

The general method of proceeding is as follows:—About 500 grains of the cheese should be incinerated, and the ash tested for lead and iron as directed under the head of Annatto, &c.

Import duty, 2*s.* 6*d.* per cwt.; from British possessions, 1*s.* 6*d.* per cwt.

Imports taken for home consumption in 1854, 390,220 cwts.; in 1855, 381,282 cwts.; in nine months of 1856, 275,044 cwts.

COLOURED SUGAR CONFECTIONERY.

THE adulteration of articles of sugar confectionery is a subject of the very greatest importance in a sanitary point of view: that it must be so is evident when we consider the poisonous character of many of the substances used, and also the large consumption of these articles, especially by children and young persons.

That these articles are subject to gross and injurious adulteration has long been known, and the subject is particularly referred to even by Accum and other early writers on adulterations. Dr. O'Shaughnessy, in the preface to a paper on coloured sugar confectionery, published in the "Lancet," in 1833, makes these remarks: —

"In the following observations it is my principal aim to lay before the public and the medical profession a calm, dispassionate statement of the existence of various poisons (gamboge, lead, copper, mercury, and chromate of lead) in several articles of confectionery, the preparation of which, from their peculiar attractions to the younger branches of the community, has grown into a separate and most extensive branch of manufacture. I am fully aware of the hazardous task that individual undertakes who ventures in this country to signalise such abuses."

ON THE ADULTERATIONS OF SUGAR CONFECTIONERY.

Of all the chief varieties of articles of sugar confectionery, we subjected no less than 101 samples to both microscopical and chemical examination.

From an examination of this extensive series of analyses of coloured sugar confectionery, it appears —

That the principal colours employed are yellows, reds, including pink and scarlet, browns, purples, blues, and greens.

Of the yellows —

That *Seven* were coloured with LEMON CHROME, or the pale variety of CHROMATE OF LEAD.

That *Five* were coloured with ORANGE CHROME, or the deep variety of CHROMATE OF LEAD.

That *Forty-seven* were coloured with the bright or canary-coloured variety of CHROMATE OF LEAD.

That *Eleven* of the samples were coloured with GAMBOGE.

While the colour of the majority of the above samples was confined to the surface, in many cases it was diffused equally throughout the whole mass of the sugar used.

Of the reds —

That *Sixty-one* were coloured with *organic pink* colouring matters, consisting in most cases of *Coccus Cacti*, or *cochineal.*

That in *Twelve* of the samples the colouring matter was RED LEAD, RED OXIDE OF LEAD, or MINIUM.

That in *Six* cases the colouring ingredient consisted of VERMILION, CINNABAR or BISULPHURET OF MERCURY.

Of the browns —

That *Eight* were coloured with *brown ferruginous earths*, either *Vandyke brown*, *Umber*, or *Sienna.*

Of the purples —

That two samples were coloured with a mixture of *Antwerp blue*, which consists principally of Prussian blue, and an organic red pigment, most probably *cochineal.*

Of the blues —

That *One* was coloured with *indigo.*

That *Eleven* were coloured with *Prussian blue*, or *ferrocyanide of iron.*

That *Eleven* were coloured with *Antwerp blue*, which is a modification of *Prussian blue.*

That in *Fifteen* samples the colouring matter consisted of GERMAN OR ARTIFICIAL ULTRAMARINE, which is a double silicate of alumina and soda with sulphuret of sodium.

Of the greens —

That *Five* samples were coloured with the *pale variety* of BRUNSWICK GREEN.

That *Four* were coloured with *middle* BRUNSWICK GREEN.

That *One* was coloured with the *deep variety* of BRUNSWICK GREEN.

These greens consist of a mixture, in different proportions, of the CHROMATES OF LEAD and *Prussian blue.*

That one sample was coloured with VERDITER or CARBONATE OF COPPER.

That *Nine* were coloured with SCHEELE'S GREEN, EMERALD GREEN, or ARSENITE OF COPPER.

That in *Four* of the samples, the colours used were painted on with WHITE LEAD or CARBONATE OF LEAD. This was the case in all the cake ornaments.

It further appears from the above analyses —

That *Thirteen* of the samples were adulterated with *hydrated sulphate of lime*, the quantity varying from 4·3 to 43·66 per cent.

That *Twenty-one* of the samples were adulterated with different kinds of *Flour*, in quantities varying from 1·66 to 25·56 per cent. In *Seventeen* samples the farina consisted of *wheat flour;* in *Three*, of *potato flour*, and in *One*, of *East India arrowroot.*

The above colours were variously combined in different cases; as many as three, four, five, six, and even seven colours, occurring in the same parcel of confectionery, including three and even four poisons.

The following specimens are of this kind: —

Sugar Seeds.

The colours of one sample of sugar seeds were *crimson*, *pale pink*, *light blue*, *dull greenish-blue*, *light grass-green*, *orange-yellow*, and *lemon-yellow*, intermixed with white globules. The colouring ingredients employed were: for the crimson and pink, the usual *non-metallic red;* for the blue, *Antwerp blue;* for the dull greenish-blue, VERDITER, containing LEAD; for the grass-green, PALE BRUNSWICK GREEN; and for the orange and bright yellows, the orange and yellow CHROMATES OF LEAD, in large quantity. *Ash*, light reddish-brown, 1·06 per cent.; matter insoluble in water, chiefly *wheat flour*, 9·60 per cent.

Thus no less than *three active poisons* containing LEAD and COPPER were present in this sample in considerable amount.

Dog and Hare.

The nose and ears of the dog, and the tongue of the hare, are coloured bright red with VERMILION. The body of the dog is spotted with large patches of GAMBOGE and *burnt umber*, as also was the figure of the hare which lay at its feet; while the green pigment on the base, of which there was a very large quantity, contained CHROMATE OF LEAD, and consisted of the pale variety of BRUNSWICK GREEN. *Ash*, dark reddish-brown, 2·0 per cent.

Mixed Sugar Ornaments.

The confectionery in this parcel is made up into a variety of forms and devices, as hats, jugs, baskets, and dishes of fruit and vegetables. One of the hats is coloured yellow with CHROMATE OF LEAD, and has a green hatband around it coloured with ARSENITE OF COPPER; a second hat is white, with a blue hatband, the pigment being *Prussian blue.* The baskets are coloured yellow with CHROMATE OF LEAD; into the colouring of the pears and peaches the usual *non-metallic red pigment*, CHROMATE OF LEAD, and MIDDLE BRUNSWICK GREEN, enter largely; while the carrots represented in a dish are coloured throughout with RED OXIDE OF LEAD, and the tops with the same green. This is one of the worst of all the samples of coloured sugar confectionery submitted to analysis, as it contains no less than *four deadly poisons.*

Twelfth Cake Ornaments.

The ornaments in this parcel consist of a ship in full sail, a duck, a fox, and a bunch of flowers, the principal colours being green, yellow, red, and brown; the chief pigments employed are CHROMATE OF LEAD, RED OXIDE OF LEAD or RED LEAD, VERMILION, *sienna*, and ARSENITE OF COPPER: these being present in poisonous quantity.

It will be observed that the list of colouring matters above enumerated includes some substances of an injurious character, and many which are amongst the most virulent and deadly of the mineral poisons. Of those which may be considered as more or less injurious, are *Ferrocyanide of iron* or *Prussian blue*, *Antwerp blue*, GAMBOGE, and *German* or *artificial ultramarine.* Amongst those which are deadly and poisonous, are—the three CHROME YELLOWS or CHROMATES OF LEAD; RED LEAD or RED OXIDE OF LEAD; WHITE LEAD or CARBONATE OF LEAD; VERMILION or BISULPHURET OF MERCURY; the three BRUNSWICK GREENS; VERDITER or CARBONATE OF COPPER; and EMERALD GREEN, SCHEELE'S GREEN, or ARSENITE OF COPPER.

Other articles which have been stated to be used in the colouring of sugar confectionery, and most of which we have ourselves detected, are *clay*, *chalk*, *Naples yellow* or *sulphuret* of *arsenicum*, *massicot* or *oxide of lead*, *acetate* and *oxichloride of copper.*

It may be alleged by some that these substances are employed in quantities too inconsiderable to prove injurious; but this is certainly not so, for the quantity used, as is amply indicated in many cases by the eye alone, is often very large, and sufficient, as is proved by numberless recorded and continually occurring instances, to occasion disease, and even death. It should be remembered, too, that the preparations of lead, mercury, copper, and arsenic, are what are termed cumulative—that is, they are liable to accumulate in the system little by little, until at length the full effects of the poisons become manifested. Injurious consequences have been known to result from merely moistening wafers with the tongue; now the ingredients used forcolouring these include many that are employed in sugar confectionery: how much more injurious then must the consumption of sugar thus painted prove, when these pigments are actually received into the stomach!

That deadly poisons, like the above, should be daily used for the mere sake of imparting colour to articles of such general consumption as sugar confectionery—articles consumed chiefly by children, who from their delicate organisation are much more susceptible than adults—is both surprising and lamentable. It is surprising, on the one hand, that the manufacturers of these articles should be so reckless as to employ them; and, on the other, that the authorities should tolerate their use.

Dr. Thomson furnished the Parliamentary Committee on Adulteration with the following particulars regarding the adulteration of sugar confectionery with *terra alba* or *sulphate of lime:*—

"I procured from a great manufactory of those substances specimens at different prices. There were about ten different samples, of which I have the details here; I will first speak of what are called mints, at 7*d.* a pound; they contained 3·03 per cent. of a substance which is sold under the name of terra alba. This terra alba I found to be plaster of Paris. The second sample, at 84*s.* per cwt., contained 20·84 per cent. of terra alba. The third was carroways, at 5*d.* a pound, and contained 27·82 of terra alba. The fourth, another specimen of carroways, at 8*d.* a pound, contained 19·22 per cent. of terra alba. The sixth, almonds, at 10*d.* a pound, contained ·96 per cent. of terra alba. The seventh, another sample, at 8*d.* a pound, contained 7·02 per cent. of terra alba. The eighth sample, at 8*d.*, contained 22 76 of terra alba. Raspberries, at 9*d.* a pound, contained 7·76 of terra alba. Strawberries, at 9*d.* a pound, contained 8·28 per cent. of terra alba.

Mr. Gay states, in the course of his evidence before the Committee on Adulteration:—

"I believe many articles of confectionery are adulterated; I think carraway comfits are very extensively adulterated, and also many of the peppermint lozenges. I believe the basis of both those and coriander and almond comfits are flour; after the seeds are put into the pan, a little syrup is thrown over them, and that is dusted over with either flour or whiting, or plaster of Paris; a pretty strong coat is put upon them in this way, and then they are finished with a stronger and better syrup."

White lead used in sugar cake ornaments is itself often extensively adulterated with sulphate of barytes.

Further, many articles of sugar confectionery are flavoured with "essences," which are often of an injurious and even dangerous character, some of them containing prussic acid and fusil oil.

In reference to the use of these essences, much information will be found in the evidence given before the Parliamentary Committee on Adulteration.

Amongst the essences used to flavour sweet confectionery, are some prepared from oil of grain or fusil oil. Pineapple drops are said to owe their flavour to an essence prepared from that deleterious substance.

Other compounds prepared from fusil oil are made to imitate the flavour of Jargonelle pears and ribstone pippins. "I have heard," states Professor Taylor, "that some of the Jargonelle pear drops and the ribstone pippin drops have produced drowsiness and stupor in children. It is an imposition on the public to sell in this way a chemically flavoured substance under another name."

A very fragrant fruity essence may be produced from rotten cheese, by treatment with sulphuric acid and bichromate of potash.

Another essence extensively used for flavouring sweetmeats and confectionery is ratifia, essential oil of almonds, or essence of peach kernels. It is obtained by distilling bitter almond cake with water, and it contains from six to twelve per cent. of prussic acid, but is most variable in its strength. As small a quantity as twenty drops has been known to occasion death.

There is another compound of prussic acid, called "almond flavour:" it contains about one drachm of the essential oil to seven drachms of spirit, but its strength varies very much. Many fatal cases have resulted from the use of this flavouring substance.

The prussic acid in these preparations is not essential to their flavour, and might with a little care be readily separated, so that, as Professor Taylor remarks in his evidence before the Parliamentary Committee on Adulteration, "there is no excuse for selling prussic acid in these compounds but laziness and ignorance."

Lastly, the *papers* in which the ornaments are wrapped are usually coloured with various poisonous pigments,—a practice which ought to be forbidden, since children are very apt to put these papers in their mouths and suck them.

In some other countries, as France, Belgium, and Switzerland, manufacturers of sugar confectionery have long been forbidden to use injurious colouring ingredients under severe penalties. Sellers of these articles in Paris are also obliged to put their names on every parcel of confectionery they sell; they are held responsible for all accidents which may arise from their consumption, and they are even forbidden to wrap the articles in coloured papers.

Following the example of the Council of Health of Paris, we now furnish two lists, one of colours the use of which may be permitted, and the other, of those colours the employment of which should be strictly prohibited, on the ground that they are all more or less dangerous to the public health, and most of them absolutely poisonous: —

List of Colours, the Use of which may be permitted.

YELLOWS.

Saffron.
Turmeric.
French berries.
Lake of ditto, or yellow lake.
Persian berries.
Lake of ditto.
Quercitron bark.
Lake of ditto.
Fustic wood.
Lake of ditto.

REDS.

Cochineal.
Lakes of ditto,
Carmine and
Brazil wood.
Lakes of ditto.
Pink madder lake.

PURPLES.

Madder purple.
Logwood and indigo.
Any of the lakes, with indigo or litmus.

List of Colours, the Use of which should be prohibited.

YELLOWS.

Gamboge.
The three chrome yellows, or chromates of lead.
Massicot, or protoxide of lead.
Yellow orpiment, or sulphuret of arsenicum.
King's yellow, or sulphuret of arsenicum, with lime and sulphur.
Iodide of lead.
Sulphuret of antimony, or Naples yellow.
Yellow ochre.

REDS.

Red lead, minium, or red oxide of lead.
Vermilion, or bisulphuret of mercury.
Red orpiment, realgar, or bisulphuret of arsenic.
Iodide of mercury.
Red ferruginous earths, as Venetian red, &c.

BROWNS.

Vandyke brown.
Umber.

PURPLES.

All purples resulting from the mixture of any of the prohibited reds or blues.

BLUES.

Prussian blue, or ferrocyanide of iron.
Indigo.
Antwerp blue, a preparation of Prussian blue.
Cobalt.

List of Colours, the Use of which may be permitted.

BLUES.

Indigo.
Litmus

GREENS.

Sap green (juice of Rhamnus catharticus).
Yellow lake, or French berries and indigo.
Any of the vegetable yellows, or lakes, with indigo, including Persian berries and indigo.

Obs. — Of the above colours one, *sap green*, is certainly liable to injurious adulteration, and it is stated that *litmus* is so likewise.

List of Colours, the Use of which should be prohibited.

BLUES — *continued.*

Smalt, a glass of cobalt.
Blue verditer, or sesquicarbonate of copper.
Ultramarine, a double silicate of alumina and soda, with sulphuret of sodium.
German or artificial ultramarine, which resembles in its composition natural ultramarine.

GREENS.

The three false Brunswick greens, being mixtures of the chromates of lead and indigo.
Mineral green, green verditer, or subcarbonate of copper.
Verdigris, or diacetate of copper.
Emerald green, or arsenite of copper.
The true Brunswick greens, or oxychlorides of copper.
False verditer, or subsulphate of copper and chalk.

THE VARIOUS BRONZE POWDERS.

Gold, silver, and copper bronzes; these consist of alloys, in different proportions, of copper and zinc.
White lead, or carbonate of lead.

By an examination of these lists, it will be perceived that nearly all the substances now employed by the manufacturers of coloured sugar confectionery belong to the second or prohibited list. Even the first list contains the names of two or three colours, the use of which is not wholly free from objection, — as indigo, litmus, and sap green; the two latter in consequence of their liability to adulteration. Genuine litmus, being a vegetable colour, is of course harmless; but its use is rendered objectionable from its being frequently adulterated, according to M. Andral, with common arsenic and peroxide of mercury.

From ultramarine, in contact with an acid, sulphuretted hydrogen is freely liberated; and this liberation no doubt takes place readily in the stomach when any confectionery coloured by this pigment is partaken of: hence the use of this pigment is objectionable.

For ourselves, we altogether object to the practice of colouring articles of consumption of all kinds and descriptions: while it merely gratifies the sense of sight, it serves to conceal other adulterations, and is attended in a variety of ways with the greatest danger to health. The danger arises, not merely from the wilful employment of substances of known hurtfulness, but also from their use through ignorance and accident. The excuse of ignorance may tell somewhat in favour of manufacturers, who in some cases may not be aware of the deadly nature of the articles which they daily use, knowing them only by their common or popular names.

Serious as the results recorded in these analyses really are, we have reason to believe that, some years since, things were even worse, and that nothing was more common than to meet with articles of sugar confectionery coloured with verdigris or acetate of copper, with the verditers or carbonates of copper, and with mineral green or arsenite of copper, all of which are virulent poisons.

A few of the cases of poisoning resulting from the use of coloured sugar confectionery, will be found recorded in "Food and its Adulterations."

On the Detection of the Adulterations of Sugar Confectionery.

We will now proceed to give some brief directions, which may prove of assistance to others who may desire to analyse for themselves any suspected samples of coloured confectionery. We shall, however, confine our directions chiefly to the detection of those substances which we have ourselves discovered in the different samples subjected to examination. From the large number of analyses which we have made, and the results of which we have already made known, the pigments detected will embrace certainly all the most important of those which are ordinarily employed in the colouration of confectionery.

Of the colours used, some are soluble in water, and others insoluble; the former include nearly all the vegetable colours, and the latter most of the mineral colours. In this particular, therefore, there is a broad distinction between vegetable and mineral colouring matters, which will be found very useful in guiding us in our subsequent operations.

In the majority of cases there is but one colouring matter present, and this is usually confined to the surface of the various articles of confectionery, while in other cases different colours are used in the same article. When the colour is confined to the surface, it is readily removed by washing in distilled water, from which, if mineral or insoluble, it will usually be precipitated after standing for some time, and it may then be obtained in an almost unmixed state, and weighed. When the colour is diffused throughout the whole of the article, the same end can be accomplished by dissolving it in water; the sugar will be removed by the water, and the colouring matter will subside. But should the article contain starch, or any other insoluble substance, it, of course, goes down with the colouring matter. When different colours occur in the same article, they must each be cut out with a knife, and separately washed and tested.

In many cases a shorter method of proceeding than the above may be adopted. The confectionery, when it is supposed to be coloured with a fixed metallic salt, may be incinerated in a capsule, and the ash tested.

Nearly all the pigments used may be referred to one or other of the following colours: *red*, *yellow*, *blue*, *green*, *brown*, and *purple;* other tints occur, which are formed by various combinations of the primary colours.

Vegetable and Animal Reds.

If the *red* or *pink* colouring matter be of a *vegetable* nature, or indeed if it consist of a solution of *Coccus cacti* or *cochineal*, this may be ascertained by simply immersing small portions of the coloured comfit or lozenge, the one in a solution of caustic potash, and the other in acetic acid; if it be a vegetable colour, or the animal colouring matter cochineal, it will become purplish in the alkaline, and brilliant red in the acid solution. If the colour be not thus affected, then there is reason to suppose that it is a mineral colouring matter, most probably either red lead or vermilion. Inasmuch as many red and pink comfits, &c., are coloured with non-metallic colouring matter, it is as well to try them all in this way in the first instance, and so save ourselves the trouble of analysing each for metallic pigments.

Mineral Reds.—The *lead of the red oxide* may be obtained either by washing or by incinerating the comfits.

If we desire simply to ascertain whether the red pigment consist of lead or not, we have only to treat it with a drop or so of nitric acid, and to add subsequently a little solution of sulphuret of ammonium; these reagents may often be applied to the pigment upon the article of sugar confectionery, by which means we are enabled to ascertain in a minute or so whether the colouring matter consist of or contain lead or not. We may proceed in the same way to detect the lead in massicot, in the chromates of lead, either pure or when mixed with Prussian blue, as in the different Brunswick greens, only that in the case of the chromates and Brunswick greens it is best to use hydrochloric acid as a solvent for the lead.

We have stated that most of the mineral pigments may be procured in a separate state by washing out the sugar. Having in this case, by a preliminary trial ascertained that the pigment we have to deal with consists of red lead, we have nothing more to do than to dry and weigh it in order to determine the quantity present.

But in some cases, owing to the use of starch, chalk, or other adulterating ingredient, it will not be possible to obtain the preparation of lead or other pigment in a separate state. We must then proceed as follows, to determine the amount of lead present: —

The lead must be precipitated from the solution of the ash, either as a sulphuret or an iodide of lead: this must be collected, dried, weighed, and the lead calculated from it.

There is one source of fallacy which must be guarded against. If the sugar be adulterated with sulphate of lime, the lead may escape detection proceeding in this manner, in consequence of its being converted into a sulphate, in this case the soluble portion of the ash having been removed, the remainder should be fused with a mixture of nitre and bisulphate of potash; the residue, after having been well washed with water, is to be treated with a solution of ammoniacal tartrate of ammonia, by which means the sulphate of lead is taken up, and may be precipitated by means of sulphuretted hydrogen.

The *bisulphuret of mercury* or *vermilion*, after being obtained in as pure a state as possible by washing, must be dissolved in aqua regia, nitro-hydrochloric acid, and must be tested for in the manner described at p. 377. It is no uncommon thing to meet with, in the same red pigment, both lead and mercury, vermilion being very subject to adulteration with red lead.

Detection of the Yellow Colours.

The *yellows*, like the reds, may be either *vegetable* or *mineral;* but contrary to what was found to be the case with the reds, the yellow colouring matters employed are for the most part mineral, consisting of *lemon* or *orange-chromes*, both these being *chromates of lead*, and sometimes of either *Naples yellow* or *massicot.*

Mineral Yellows. — All the yellows should therefore be tested for lead in the first instance. For this purpose the surface of the comfit should be touched with hydrochloric acid, which usually destroys the colour at once if it be a salt of lead, especially a chromate; afterwards a drop of a solution of sulphuret of ammonium should be applied to the same spot as the acid, when, if lead be present, it will become more or less black according to the quantity. If the pigment contain lead, in all probability it is one of the chromates, and if not one of these, *massicot*, which consists of the protoxide of lead. The colour of *Naples yellow* is almost sufficient to distinguish it from the chromates of lead.

The chromic acid of the chromate of lead is to be detected by the process given in the article on Snuff. The chromates of lead may also be discriminated from massicot in most cases simply by their colour.

Naples yellow or *sulphuret of antimony*, may be thus identified:— Dissolve the pigment in hydrochloric acid, add tartaric acid diluted with water, treat with sulphuretted hydrogen, when, if antimony is present, an orange-red precipitate will subside very different from that of sulphuret of arsenic. Another way is to sublime the antimony in a test tube, and to examine the metallic crust with the microscope.

Vegetable Yellows.—Those articles which are not found to contain lead should be subsequently tested for *gamboge*, which is the next pigment most commonly employed; and if it do not prove to be this, then a portion of the comfit should be immersed in a solution of caustic potash, when, if it become decidedly browned, the colouring matter will be vegetable, and most likely *turmeric*, *saffron*, or *yellow lake*, which is usually formed from the colouring matter of French berries thrown down by alumina or lime, but it may be made from any vegetable yellow: these vegetable yellows are not very frequently employed, probably on account of their liability to alter and fade on exposure to the air and light,—an objection which also applies, though in a less degree, to gamboge.

If the pigment be *gamboge*, it will form, with distilled water, a yellowish opaque emulsion, which will not let fall any deposit. This emulsion should be evaporated to dryness, and alcohol added to the residuum; the alcohol will take up the gamboge, and when water is added to the solution, the gamboge will be precipitated. If to the yellow precipitate a drop or two of strong ammonia be now added, it is redissolved, producing a blood-red solution, from which it is precipitated pale yellow by nitric acid. Turmeric gives nearly the same reactions, and therefore much care is requisite to discriminate between the two. Turmeric does not form so decided an emulsion with water as gamboge.

On the Detection of the Blue Colours.

The *blues* may be also either *vegetable* or *mineral:* the former include *litmus* and *indigo;* and the latter, *Prussian blue, Antwerp blue*, the two *verditers*, which consist of *carbonate of copper*, the only difference between them being, that the paler verditer is diluted with lime; *cobalt; smalt*, which is a glass of cobalt powdered; and *artificial ultramarine*, which is made in imitation of true ultramarine or lazulite.

Vegetable Blues.—The vegetable blue, *litmus*, is sufficiently distinguished by its becoming red on the addition of weak acids. This pigment is manufactured from several species of a lichen (*Rocella*), and, when genuine, is innocuous. In a Report of M. Andral, addressed some years since to the Prefect of Police, it is stated that some manufacturers mix common arsenic and peroxide of mercury with litmus, and M. Andral therefore considers that its use in the colouring of sweet confectionery should be prohibited.

Indigo is sufficiently distinguished by its subliming in dense violet vapours when heated, by forming a blue solution with concentrated sulphuric acid, and by its remaining unchanged in alkalies.

Mineral Blues.—The colour of *ferrocyanide of iron*, or *Prussian blue*, is immediately discharged on the addition of the caustic alkalies, the iron being thrown down in the state of peroxide, when, if necessary, the iron may be collected and weighed; the colour is also destroyed by incineration, the red oxide of iron only being left, which may be weighed and calculated into Prussian blue.

Antwerp blue is Prussian blue, the colour of which is rendered lighter and brighter in consequence of its dilution with some colourless material, usually chalk. The tests for Antwerp blue are therefore the same as for Prussian blue, those for carbonate of *lime or chalk* being superadded. This and the preceding pigment is in general sufficiently distinguished by adding a drop or so of solution of ammonia or potash direct to them upon the sugar, these reagents at once destroying the blue colour.

The *Verditers* are *carbonates of copper;* they are distinguished from other salts of copper by the escape of carbonic acid on the addition of any mineral acid: when boiled for a long time, or heated carefully, the carbonic acid escapes, and the pigment becomes brown. The tests for copper, and the method by which it may be determined quantitatively, will be found described under the head of Pickles and Preserves.

The remaining blue pigments, *cobalt*, *smalt*, and *ultramarine*, are distinguished by their colour being fixed in the fire, so that the ash of sugar articles coloured with any of these substances is of a bright blue, the tint varying according to the blue used, as well as also in consequence of admixture with uncoloured substances, such as chalk, sulphate of lime, or pipe clay. These colours are somewhat expensive, especially the true ultramarine, but they are of such intensity that a little goes a great way; there is, however, a cheap kind of ultramarine, sold in the shops as *German or French ultramarine*, the price being about sixpence per ounce, and it is this blue pigment which is chiefly employed in the colouring of sugar confectionery. It consists of a double silicate of alumina and soda with sulphuret of sodium, and it may be distinguished, when free from admixture with other substances, by adding to it a little hydrochloric acid, and observing the odour of sulphuretted hydrogen evolved. This method of discrimination is, in the case of coloured sugar confectionery, for the most part inapplicable, since sulphuretted hydrogen is almost invariably thrown off whenever hydrochloric acid is added to the ash left on the incineration of most articles of sugar confectionery. The pigment ought therefore to be procured in a separate state, by washing, and the acid applied to it when dry.

On the Detection of the Green Colours.

Vegetable Greens.—Of the *greens*, there is but one *vegetable* green used—namely, *sap green.* This is prepared from the green berries of the buckthorn, *Rhamnus catharticus;* but its use is to be objected to on account of its frequent adulteration with green metallic pigments, containing either copper or arsenic, in order to heighten its colour and render it more permanent. It is bleached by chlorine and acids.

Metallic Greens.—Of the *metallic greens*, some are simple colours, while others are composed of a blue and a yellow mixed. *The simple greens* are *acetate of copper* or *verdigris*, and *arsenite of copper*, *emerald green* or *Scheele's green.*

Acetate of copper is distinguished from other green salts of copper by the action of sulphuric acid; the acetic acid is liberated, and may be detected by its odour.

Arsenite of copper is best recognised by means of the arsenic, of which it is in part composed: a portion of the colouring matter separated from the sugar by washing, when perfectly dry is placed in a test tube open at both ends, the heat of a spirit lamp being applied outside the tube; this will cause the arsenic to sublime, and, condensing on the cool side of the tube, it forms a bright metallic crust, which, examined with a low power of the microscope, is ascertained to consist of minute octohedral crystals. This test is perfectly conclusive.

The *compound greens* ordinarily used are those commonly sold as *Brunswick greens;* they are the colours usually employed in making green paint, and are of three different tints, known as pale, middle, and deep Brunswick. They consist of a mixture, in various proportions, of usually *Antwerp blue*, but sometimes *ultramarine*, and *chromate of lead.* When obtained in any quantity from the confectionery, and diffused through water in a shallow dish, the two colours easily separate, and may be distinguished by the eye alone.

They may usually be recognised without the trouble of procuring them in a separate state by washing, by adding reagents direct to these pigments as they cover the sugar ornament. If ammonia or potash is added, the green colour disappears, and is replaced by a yellow; that of the Prussian blue being destroyed by the alkali, the chromate of lead comes into view again; if the pigment is touched with hydrochloric acid it becomes blue, this arising from the solution of the chromate of lead by the acid. These are ready and very satisfactory tests. Other compound greens are occasionally made by mixing a yellow pigment, usually *pale chrome*, with one or other of the verditers. The true Brunswick greens are *oxichlorides of copper*, but these, being very expensive, are seldom employed.

The *oxichlorides of copper* may be thus distinguished from the other green salts of copper. Dissolve the pigment in a little pure and dilute nitric acid, add nitrate of silver, when, if a white precipitate ensues, it consists of chloride of silver, which is soluble in ammonia.

On the Detection of the Brown Colours.

They are distinguished by the iron contained in them.

On the Detection of the Purple Colours.

The *purple colour* sometimes met with in sugar confectionery is usually composed of a mixture of *Antwerp blue* and some *vegetable pink*, as *rose-pink*, the *lakes*, or *cochineal*. We must therefore test for the pigments named by the methods already indicated.

On the Detection of Bronze Powders.

Bronze powders consist of an alloy of copper and zinc: usually they are sufficiently distinguished by their metallic appearance; in doubtful cases they may be dissolved by means of nitric acid, the excess of acid got rid of by evaporation, and the aqueous solution tested for copper and zinc; the solution should be separated into two equal portions, the one tested for copper in the usual manner, and the other for zinc by means of sulphuretted hydrogen, which throws down a white sulphuret of zinc.

Having completed the description of the methods by which the numerous pigments employed to colour sugar confectionery may be detected, it now remains only to indicate the processes by which the other substances, not pigments, either ascertained to be used by ourselves or others in the adulteration of sugar confectionery, may be discovered.

The principal of these substances are various kinds of *starch*, *chalk*, *sulphate of lime*, *hydrated sulphate of lime*, *plaster of Paris* or *gypsum*, and *white potters' clay*, *pipe clay*, or *Cornish clay*.

On the Detection of Chalk, Plaster of Paris, and Clay.

Ordinary *plaster of Paris*, although stated to be employed in the manufacture of confectionery intended to be eaten, can scarcely ever be so, since when this is moistened with water it quickly becomes solid, retaining its solid state after incineration; on the other hand, hydrated sulphate of lime does not remain solid, and when exposed to a red heat, it is still a powder. The process for the qualitative and quantitative determination of this salt is described at p. 99.

Chalk is sufficiently identified by its appearance, by its effervescing on the addition of an acid, and by the lime which is thrown down from its solution by oxalate of ammonia. See p. 101. Alumina is detected by the process indicated at p. 180.

On the Detection of the Different Kinds of Starch.

The kind of *starch* employed is detected by means of the microscope. A minute portion of the sugar should be placed upon a slip of glass and a drop of water added, if the sugar dissolve without any appearance of residue, the solution being quite transparent, the probability is that no starch is present, but if there be any residue, this should be placed under the microscope, when the starch, if present, will usually be recognised by the form of the granules, but should the starch be in an amorphous state in consequence of its having been boiled, then a little iodine should be added to the residue, which will at once reveal its presence. The quantity may be estimated in either of the following ways:—When starch only is mixed with the sugar the latter may be dissolved out, and the precipitated starch dried and weighed; but when any other insoluble substance is present the precipitate left after the removal of the sugar may be burned, and the loss of weight will give very nearly the quantity of starch; or the precipitate may be boiled in water; the starch will be taken up, and the insoluble matter will subside; the supernatant liquid can then be decanted from the deposit, and the starch obtained on evaporation or by precipitation in the form of an iodide, by means of a solution of iodide of potassium.

Until the 5th of April, 1857, the duty on sugar confectionery will be 2½*d.* per lb.; till the 5th of April, 1858, 2*d.* per lb.; thenceafter, 1½*d.* per lb.

Succades and all fruits and vegetables preserved in sugar are charged the same duty, such as citron peel, &c.

Gross amount of duty received upon Confectionery in the year 1854, 535*l.*; 1855, 629*l.*

Imports in 1854, 73,347 lbs.; in 1855, 69,559 lbs. Retained for home consumption in the first year, 64,708 lbs.; in the second, 62,368 lbs.

PORTER, AND ITS ADULTERATIONS.

PORTER and stout should be brewed of malt and hops only, and the colour, as well as flavour, should be due to these alone.

The colour of all malt liquors is dependent upon the degree of heat to which the malt has been subjected in the kiln, and upon the amount of ripeness the hops have attained before being stripped from the poles. Thus, for the pale bitter ales the greatest care is necessary to prevent the husk of the malt from charring in the least, and to maintain the original straw colour of the barley; and in the selection of the hops, that they should be picked as soon as sufficiently ripe to keep, and that no single brown or withered leaf should be suffered to remain. The reverse of all this is the case with the malt and hops required for porter. The malt should be briskly dried, until the flower of the grain is of a light brown colour, and crushes with a crisp friability between the teeth; the hops, also, should have hung in the autumn sun till they have attained a rich golden hue, and the seeds are perfectly developed. With all attention to these requirements, however, the beer brewed would still be far from the necessary colour and flavour, and to attain these the maltster is compelled to prepare malt in a peculiar manner. It must be remembered, nevertheless, that the strength of the porter is due almost entirely to the pale malt, as the other kinds have their saccharine properties so altered by roasting as to render them nearly useless, except for colour and flavour, as before mentioned.

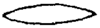
In addition to these distinctive properties of porter and stout, there is one other of still greater importance—the peculiarity of the fermentation. Up to the commencement of this last stage of the process of brewing, the manufacture of porter is conducted in exactly the same manner as that of ale, with the addition of the different flavouring malts before mentioned; but during the fermentation the great difference is effected, as all the sugar is converted into spirit, excepting only such portion as is required to preserve the beer from the acetous fermentation, which is less than in ale, by reason of the larger amount of hops used in proportion to the strength of the wort. The difference will be best appreciated by the annexed figures. Good porter should weigh about twenty-two pounds specific gravity above water per barrel of thirty-six gallons before the fermentation, and single X ale about the same; but after fermentation, the porter will be found to retain only five pounds weight per barrel, while the ale has seven. Thus, ordinary ale is more liable to derange the stomach, by reason of its greater sweetness, while porter is more heady in proportion to its strength, and soporific in its tendency, from the strong infusion of hops in its composition.

It may be interesting to make a few remarks, succinct as possible, upon the preparation of malt and hops before they come into the brewers' hands; and upon isinglass, the only substance which should be used for fining beer. It may be well to observe, before doing this, that sugar is permitted by law to be used for brewing, and has been and will be consumed extensively whenever malt rises to a sufficiently high price to render it profitable: nevertheless, it is advisedly the dogma that "porter and stout (and indeed all malt liquors) should be brewed of malt and hops only," as was enunciated in the commencement of this article; for beer brewed from sugar has greater tendency to the acetous fermentation than malt liquor, so that, setting aside the undoubted superiority of flavour in the latter, the risk, both pecuniary and otherwise, attending the use of sugar, is too great to tempt the prudent man of business.

Malt.

Malt is barley in which germination has been carried on to a certain extent, and then suddenly cut off by the application of heat: the process is conducted as follows:—After steeping the barley in a cistern of water till well swollen, it is thrown in layers on the slate floors of the long malt-house, buildings well known; it then germinates quickly; it is not, however, allowed to rest, but is turned over from time to time, until every grain has been alike exposed to the air, and to such light as is permitted to enter, which is not great, as the growth would otherwise be forced too speedily, the object to be attained being the conversion of the starch into sugar, which is known to be complete when what is called the acrospire has reached three parts of the way up the grain, particularly observable by a thickening in the back of the grains of barley. During this stage the malt emits a smell resembling that of cucumber. When the grain has arrived at this condition, it is thrown into the kiln in a layer of from three to five inches in thickness, according to circumstances, and while there it is turned over once or twice in about twenty-four hours. The kiln has a wire-gauze bottom, through which the heated air from a furnace of Welsh coal ascends. The briskness of the fire and the time of drying depend upon the colour required in the malt. The process is then complete, with the exception of screening away the "malt dust,"—the dried roots of the embryo plant, a very nutritious food for cattle, and which also does duty sometimes for ground coffee, Scotch snuff, and other articles.

Barley.



Malt.

In the choice of malt, the brewer is guided by the growth of the acrospire, as, if it be not sufficiently developed, there is less saccharine matter in the grain than is requisite, and more gluten; and, if overgrown, the saccharine matter is absorbed by the progress of the germination.

Malt contains, besides saccharine matter, a substance called dyastase, which, in the mash tun, by the action of hot water, and agitation by machinery, converts the greater portion of the starch into sugar.

The *pale malt* thus manufactured is the base and strength of all malt liquors. It now remains to notice the other malts used for the purpose of flavouring and colouring stout and porter.

Amber malt, used in the proportion to pale malt of one eighth part, differs merely in being dried at last faster than the ordinary kind, and by a hotter fire. The delicacy of the flavour of stout is much dependent upon this malt.

Brown or blown malt is of a darker colour externally, but internally it is of a deep brown colour. It is manufactured by being placed in the kiln in a layer of only one inch in thickness, and dried by a fierce fire of wood in a very short space of time. This malt, used in the proportion of one half of the pale malt, is the source of the rich empyreumatic flavour of stout and porter, and does much towards its colour; but this is finally effected by what is called *patent malt*, which is of a very dark brown colour. This malt is pale malt, perfected in the kiln in the ordinary way, and then roasted in a similar manner to coffee, only on an infinitely larger scale. The colour of porter, as before mentioned, is principally due to this malt; but it is so powerful an agent, that no more than one fiftieth part of it is used in proportion to the other malts.

It is stated in most chemical works that the sugar of malt is formed at the expense of the starch. If this were so, the starch corpuscles of the barley ought to exhibit, when examined with the microscope, some evidence of this conversion in an alteration of form or substance. Under the highest powers of that instrument, however, no difference in form or outline in the granules of unmalted and malted barley is perceptible, the granules of malt simply showing a greater tendency to cohere in masses. The results of microscopical observation do not appear, therefore, to confirm the statement that the sugar of malt is derived from the starch, but they point to another constituent of the grain of barley as that which really furnishes the sugar, namely the *cellulose*. This in malt is almost entirely destroyed. Now cellulose has nearly the same chemical composition as starch, and its transformation doubtless furnishes much of the sugar of malt. The presence of the cellulose in the raw grain, and its absence in malt, may be readily shown by tearing into pieces, with needles, sections of the grains, and washing away the starch.

The fact of the disappearance of the cellulose is not only interesting in a scientific point of view, but is also of practical importance, since it supplies a ready means by which barley may be distinguished from malt, even when the two are mixed together, the discrimination for certain Excise purposes being often of much consequence.

The above observations were made principally upon samples of barley and malt kindly furnished the author by Mr. Wren, of Buntingford; to whose long experience in, and great knowledge of malting, he is indebted for many practical remarks and suggestions.

Hops.

Hops will next demand our attention; but to consider the kinds and cultivation of these fully would occupy more space than can be afforded.

Hops are a very delicate and precarious crop, affected greatly by the weather, and they also fall a prey to various kinds of blight, of which the most devastating are the *fly*, and *mould* or *rust*. The former is the well-known green insect and black fly, that attack the rose plants; and its ravages are so great, that three fourths of the years crops are sometimes sacrificed. The latter is a fungus which attacks the hop itself, and not only prevents its proper development, and thus destroys its preservative properties, but also communicates an unpleasant flavour to the beer.

Like the vine, the hop loves the sun, and can scarcely have too much of it; it also resembles that plant in the soils and situations it most prefers—the sunny sides of sloping hills, and the well-cultivated soil of Kent, resting on the Kentish rag or ironstone. The most choice hops are grown in East Kent, and the next in estimation, in mid-Kent. In ordinary seasons, the hops grown in Kent nearly suffice for all the malt liquors brewed in England; but in seasons of scarcity foreign hops are much used. Hitherto, the hops grown in Belgium have been considered the best, and, in appearance, there is no doubt they are so, as the Belgian growers have taken great pains to imitate our mode of preparation and packing; but the Bavarian hops are really much finer in quality and flavour, and the aroma is more perfectly preserved by their method of preparation, which differs from ours.

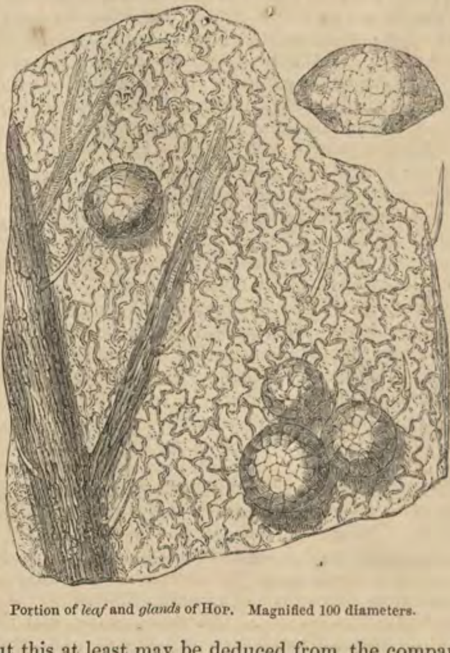
Some few hops are imported from America, but though very powerful, they are so rank and peculiar in flavour, that, without great improvement in cultivation, they are never likely to be extensively adopted.

The preparation of hops is a very simple process, and may be related in but few words. The poles, with the hop plants still hanging on them, are pulled from the ground, when the hops are picked, by women and children principally, to a great number of whom it affords a temporary employment; they are then dried on a kiln, somewhat resembling the malt kiln, but the heat is much less, and the floor of the kiln is made of hair cloth. A small portion of sulphur is burned on the kiln fire, for the purpose, in the first place, of preserving the hops—at least this is the plea, and there may be some truth in it, as the sulphur may destroy any insect or fungus remaining in the hops, but the great reason for the use of sulphur is its bleaching property, which renders the hops more sightly to the eye. After they have been thus dried and bleached they are packed, by presses, tightly into the bags, or pockets as they are called, to exclude the air. They are packed so tightly by the hydraulic press that they become sufficiently solid to be cut in blocks with a knife.

All English hops are prepared in this manner, and the Belgians, finding that the bleaching and packing have a great effect upon the eye, have followed our example; but the Bavarian growers still adhere to the custom of their ancestors, and it is to be hoped they will continue to do so, with increased attention to cultivation and packing, which will render their hops equal to the best English produce.

The mode in use in Bavaria is as follows:—When the hops are ripe the plant is cut off close to the ground, and the hops are left on the poles to dry in the sun. This method preserves the aroma entirely, and all the essential oil; the consequence is, that although they are packed loosely in bales and look like withered leaves, they have more strength and flavour in proportion to their quality than the English hops. It is somewhat premature to speak of this method as regards the preservation of the hops compared with that followed in England, as the Bavarian hops are a recent importation; in our variable climate the process by which they are dried would be unsuitable; but this at least may be deduced from the comparison, that great care should be taken in the use of the sulphur that the flavour is not affected; and also that a very low degree of heat is advisable, as there is no doubt much of the essential oil flies off in the drying process.

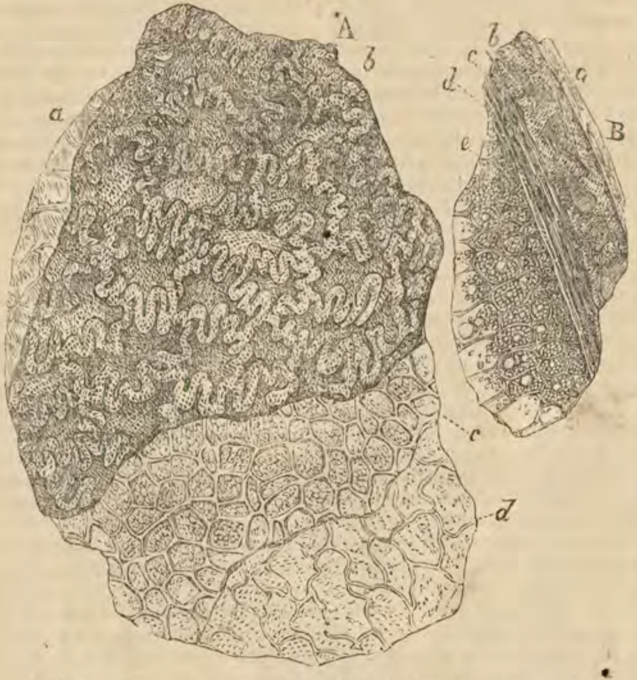
Fig. 182.



Portion of *leaf* and *glands* of HOP. Magnified 100 diameters.

Hops prepared in the foregoing manner will frequently become brown and musty by keeping: in such a condition they are wholly unsaleable; but often so great is the demand for hops that the most worthless description of foreign hops are purchased, and subjected to fumigation—by which means their colour is restored, and their property of checking fermentation revived. To effect this, as much as 10 lbs. of sulphur are employed in some cases for every hundredweight of hops. As large a quantity as 1·0 per cent. of free sulphuric acid has been met with in samples of bleached hops; this acid is formed by the oxidation of the sulphurous acid generated during the bleaching process.

Fig. 183.



Seed of Hop. A. *Testa* of, showing the four coats of which it is formed, the second, marked *b*, being the most characteristic. B. *Vertical section of seed*, exhibiting the four membranes, and the substance of the seed, *e*. Magnified 200 diameters.

Having touched, though imperfectly and cursorily, upon malt and hops, a few words upon isinglass will complete the account of the materials used in the brewing of porter. For many of the preceding details, in regard to hops especially, we are indebted to Mr. Thomas Druce, of the Hans Town Brewery, Chelsea.

Finings.

The best isinglass comes from Russia, but a very large supply from the Brazils; that used by brewers is the cartilage of the sturgeon and other fish. The brewer buys it as imported, in rough pieces, as also the dressings and pickings rejected in the preparation of the finer sorts of isinglass for the confectioner, &c. The "finings" for porter are thus prepared:—The isinglass is put into some sour beer to dissolve, technically to cut, which takes place in different times, according to the kind of isinglass made use of.

ON THE ADULTERATIONS OF PORTER.

We have now to describe the state in which the national beverage BEER, more particularly *porter* and *stout*, reaches the consumer. Like the other articles which have engaged our attention, it is of course *adulterated.*

The receipt or formula according to which the majority of articles of consumption are adulterated, is an exceedingly simple one.

First there is something added to augment the weight and bulk of the article; then something to restore the lost colour; and lastly, something to give to the adulterated and weakened compound, as far as possible, the taste and qualities possessed by the genuine commodity.

It is according to this formula that porter and stout are adulterated; first *water* is added to increase the bulk, and then *treacle*, *sugar*, and *salt*, to restore the colour and flavour.

The dilution of the beer makes it less intoxicating, and hence the occasional use of a variety of the other articles intended to impart to it the semblance of strength.

Results of the Examination of Samples.

The results of the chemical examination of *Fifty-two* samples of *stout* and *porter*, there being thirty-two of the former and twenty of the latter, procured both from brewers and publicans were:—

That the samples of STOUT either obtained from agents, or purchased at the taps of several of the principal London porter brewers, were considerably stronger than those procured from publicans; the alcohol, of specific gravity ·796, temperature 60° Fahr., contained in the former samples ranged from 7·15 per cent. the highest, to 4·53 the lowest; whereas that of the stouts procured from publicans varied, with one exception, from 4·87 per cent. to 3·25 per cent.

That the same difference of strength also characterised the various samples of PORTER procured from the two different sources; the amount of alcohol in the porters obtained from the taps varying from 4·51 per cent. to 2·42 per cent.; whereas those purchased of publicans ranged from 3·97 per cent. to 1·81 per cent.

That in nearly all the stouts and porters *salt* was present, often in considerable amount.

That in some of the samples *cane sugar* and *treacle* were likewise present.

Great as was the variation in the strength of the different samples, arising mainly from dilution with *water*, there is no doubt but that if the porter and stout had been procured direct from the brewers, in place of from the public houses known as brewers' taps, the difference would have been found to be still greater.

Such is the simplest form which the adulteration of these beverages assumes; not unfrequently it takes a more complicated and serious form.

In some cases *sulphate of iron* is added, especially to stout; it is said to give the beer a head: it of course makes it more tonic and strengthening, but sulphate of iron is a tonic which does not suit all persons; and if it is desirable that we should take it at all, since it is a medicine, it is most proper that it should be administered in suitable cases by the physician, and not by the publican or brewer.

Other substances sometimes used in the adulteration of beer are *bitters*, and *carminatives* of various kinds, as *gentian*, *quassia*, *camomile*, *ginger*, *coriander* and *caraway* seeds, *capsicum* and *grains of paradise*, as well as *liquorice*, *alum*, and *sulphuric acid*, *salts of tartar*, *carbonate of soda*, *cocculus indicus*, and *tobacco;* it is even alleged that *opium* and *strychnine* have also been employed for the same purpose.

Mr. Phillips furnished the Committee with the following information in regard to the adulteration of beer:—

"It is chiefly common salt and sulphate of iron that are used for adulterating beer, and also quassia."

Mr. Edwin Wickham's evidence was to this effect:—

"From my experience in brewing I believe that the great adulteration of beer takes place in the cellars of the publicans and not in the breweries, although I know it is done by some brewers."

Mr. Scholefield. "Do you believe that the adulteration of beer is a common thing?"—"Very common, so much so that the exception is not to adulterate; and I believe those exceptions are very few."

Mr. Wickham gives the following as the receipt in frequent use amongst publicans for the adulteration of porter:—

"To one barrel of porter eight gallons of water, six pounds of sugar, one pound of gelatine (or patent size will do), a handful of common salt, extract of gentian or quassia to restore to it the original bitter flavour, sulphate of ammonia to bring it back to its colour, half an ounce of sulphate of iron, and if required to taste oldish, an ounce of roche alum."

Again Mr. Wickham states, "I have known single instances of *tobacco* being used in beer."

Mr. P. L. Simmonds, in evidence before the Parliamentary Committee, states, that "at least 250 tons of *cocculus indicus* are annually imported, chiefly, I suppose, for the use of brewers."

He further states, "that from 200 to 300 tons of the hot acrid seeds of cardamoms, or grains of paradise, are also annually imported, and chiefly used to give an artificial strength to beer and spirits." Also that "cocculus indicus is commonly introduced into beer for the purpose of giving a false strength to it. In one case which came under my knowledge the publican was found using it for the purpose of adulterating his beer to be sold the next day."

Mr. Gay, in the evidence before quoted from more than once, gave the following information in regard to cocculus indicus:—

He states, "I have ground many cwts. of cocculus indicus."

Mr. Moffatt. "What is it used for?"—"I suspect to go into the poor man's drink."

"For whom did you grind cocculus indicus?"—"For wholesale druggists."

Mr. Rodgers alleges in his evidence that "cocculus indicus can be obtained from the brewers' druggists under the name of *multum*."

Mr. Simmonds also makes this remark in his evidence, "In the suburbs of London, I may mention that it is a common practice with the publicans to adulterate beer on Saturday nights much more than on other nights."

He likewise deduces the inference that beer is extensively adulterated, from the following statistical particulars:—

"There is one matter," he observes, "which occurs to me as being exceedingly singular, which is, that the consumption of malt and hops continued stationary, though the consumption of beer, with the increasing population, must have increased very largely. In the last fifteen years there has been scarcely any variation in the amount of hops consumed, and some substances must therefore be used very extensively to make up the difference. The extent of land under cultivation for hops in the last three years has averaged 50,000 acres, being only 7,000 acres beyond the culture of 30 years ago. The home production in the last 10 years has scarcely increased at all, and yet the shipments of beer and ale have more than trebled in value, and the home consumption must necessarily have increased also."

Another fact, proving the extensive practice of adulteration in beer, is related by Mr. Wickham, in reply to a question by Mr. Swift:—

"Is it not customary for publicans to sell the beer at the price which they pay to the brewers, so that this adulteration forms their actual profit?"—"Yes, many publicans do so."

It appears, from the analyses, that *salt* is almost constantly present in porter. This addition we know is made in the first instance by the brewers themselves; but there is also no doubt that a further quantity of it is frequently used by the publican to assist in bringing up the flavour of beer which has been reduced in strength by the addition of water.

The quantity of salt contained in porter is often sufficiently large to communicate a perceptibly saline taste to the mouth. The salt is used by the brewers in the following manner:—It is first mixed up in a tub with some kind of flour — usually wheat flour — and the mixture is cast by handfuls over the surface of the wort in the cooling vat. It is said to assist in the preservation and fining of the wort, and it is alleged that these are the only purposes for which it is employed by the brewer.

Mr. Morris, who wrote a book entitled "Brewing Malt Liquors" some years since, describes and recommends a variety of articles to be employed in the brewing of beer and porter, as colouring, cocculus indicus, sweet flag root, quassia, coriander seeds, capsicum, caraway seeds, grains of paradise, ginger, beans, oyster shells, and alum. "The colouring," Mr. Morris remarks, "gives a good face to the beer, and enables you to gratify the sight of your different customers." And again, "Beans tend to mellow malt liquor, and from their properties add much to its inebriating qualities; but they must not be used in too large a quantity. Oyster shells are very good to recover sour beer."

"Alum is generally put into the vat, as it gives the beer a smack of age."

"Cocculus indicus is used as a substitute for malt and hops, and is a great preservative of malt liquor. It prevents second fermentation in bottled beer, and consequently the bursting of the bottles in warm climates. Its effects are of an inebriating nature."

Another writer, Mr. Child *, also the author of a work on brewing porter which went through eleven editions, gives the following receipt for porter: —

1 quarter of malt.
8 lbs. of hops.
9 lbs. of treacle.
8 lbs. of liquorice root.
8 lbs. of essentia bina.
8 lbs. of colour.
Capsicum, half an ounce.
Spanish liquorice, two ounces.
Cocculus indicus, a quarter of an ounce.
Salt of tartar, two drachms.
Heading.
Ginger, three ounces.
Lime, four ounces.
Linseed, one ounce.
Cinnamon, two drachms.

The essentia bina, he states, "is compounded of 8 lbs. of moist

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* Child on Brewing Porter.

sugar, boiled in an iron vessel, for no copper one could withstand the heat sufficiently, till it comes to a thick, syrupy consistence, perfectly black and extremely bitter."

Colour "is composed of 8 lbs. of moist sugar, boiled until it obtains a middle state between bitter and sweet, and which gives to porter that mild, mellow colour usually so much admired."

The heading "is a mixture of half alum and half copperas, ground to a fine powder; and is so called from giving to porter the beautiful head of froth, which constitutes one of its peculiar properties, and which landlords are so anxious to raise to gratify their customers."

Other receipts by Mr. Morris are as follow: —

Malt, 25 quarters.

	cwt.	qrs.	lbs.
Hops - - - - -	1	2	0
Cocculus indicus berry - -	0	0	6
Leghorn juice - - -	0	0	30
Porter extract			

Malt, 20 quarters.

	cwt.	qrs.	lbs.
Hops - - - - -	2	0	0
Cocculus indicus berry - -	0	0	4
Sugar - - - -	0	0	28
Fabia amara (nux vomica) - -	0	0	6

And also the following directions: —

To make up a Vat of 150 Barrels.

"Use half a barrel of colouring, a quarter of a hundredweight of cream of tartar, a quarter of a hundredweight of ground alum, one pound of salt of steel, and two barrels of strong finings. Mix these well together, and put them in a vat, rousing it thoroughly at the same time. Let the vat remain open three days, then close it and sand it over.

"In a fortnight it will be fit for use — your own good sense will inform you how to employ it to advantage."

The extensive employment of various drugs for porter brewing led to the establishment, at about the period of the late French war, of a class of men termed "brewers' druggists." These persons issued regular price currents, and they made it their business to send travellers all over the country with lists and samples exhibiting the price and quality of the articles manufactured by them.

Mr. Accum* states that "their trade spread far and wide, but it was amongst the country brewers chiefly that they found the most customers, and it is amongst them, up to the present day, as I am assured by some of these operators, on whose veracity I can rely, that the greatest quantities of unlawful ingredients are sold."

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* A Treatise on the Adulteration of Food, p. 154.

"It was at the same time, also," writes Accum, "that a Mr. Jackson, of notorious memory, fell upon the idea of brewing beer from various drugs without any malt and hops. This chemist did not turn brewer himself, but he struck out the more profitable trade of teaching his mystery to the brewers for a handsome fee. From that time forwards, written directions and receipt-books for using the chemical preparations to be substituted for malt and hops were respectively sold; and many adepts soon afterwards appeared everywhere to instruct brewers in the nefarious practice first pointed out by Mr. Jackson."

The following remark, contained in Dr. Normandy's work, entitled "Commercial Handbook of Chemical Analysis," would lead us to infer that the fraternity of brewers' druggists is not even yet extinct:—

"It is a publicly known fact, that carts may be seen bearing the inscription, in staring paint, of 'C——, brewers' druggist.' Such a cart I have myself seen a few days ago standing, in the broad light of midday, before a publican's shop or gin palace."

Some idea of the extent to which porter is adulterated may also be formed from the two following circumstances:—

Thus it has been shown before the Parliamentary Committee on Public Houses, on the clearest evidence, that it is quite impossible for a publican to realise any profit by the sale of beer without having recourse to adulteration.

Again, Mr. M'Culloch, a witness before the same Committee, not only deposed to the fact of the extensive adulteration of beer by publicans, but he also estimated the loss to the state arising out of that adulteration at 100,000*l*., in consequence of the diminished consumption of malt.

Not only is beer itself adulterated, but frequently the very materials, out of which it is made, are also adulterated, as the hops and malt.

On the Adulteration of Hops.

In regard to the adulteration of hops, Mr. George Phillips gave the following information before the Committee on Adulteration:— "Most of the 40 samples of hops I have spoken of contained grains of paradise; in one instance we had cocculus indicus, but only in one instance."

These 40 samples of hops were examined by the Excise in twelve years, and out of them 35 were found to be adulterated, the substances met with being cocculus indicus, grains of paradise, quassia, chiretta, gentian, camomile flowers, coriander seeds, and, in one instance, exhausted tobacco.

On the Adulteration of Malt.

Barley is sometimes substituted, to the great loss of revenue, for malt. For further information in regard to this substitution, the reader is referred to pp. 502. and 514.

The remedy by which the adulteration of malt liquors may be met appears to us to be clear and simple, and it is one to which we recently had the opportunity of directing the attention of the Committee of the House of Commons on Public Houses; it is, *that no malt liquors should be permitted to be sold by any publican under certain fixed or standard strengths*, the tests of strength being not the specific gravity of the beers, but principally the amount or per centage of alcohol contained in them.

Such a regulation, properly enforced, would effectually put a stop to the adulteration of malt liquors by the addition of water, sugar, salt, and most of the other substances mentioned in this present report; and it need not in any way interfere with the different recognised strengths and qualities of malt liquors now in use, as single and double stouts, ales, and porters.

On the Detection of the Adulterations of Porter and Stout.

The *specific gravity* of the beer should be ascertained, and then its *acidity*, by means of a solution of dried carbonate of soda of known strength. The porter should next be submitted to distillation, using about 5000 grains. It is necessary that the acetic acid of the porter should be neutralised previous to distillation, otherwise it will pass over with the *alcohol*, and so affect the quantity and specific gravity of the distilled liquid. It is also advisable that fully two thirds of the liquid be distilled off, otherwise some of the spirit will remain behind. It is easy to convince oneself that this is really the case, either by distilling three separate pints of the same porter, taking off different quantities, or by removing the product of the distillation of the same sample at three different periods, when spirit will, in most cases, be found to be present in the last as well as in the first portion of liquid which comes over, although of course in greatly diminished amount.

Another measured portion of the porter, say 3500 grains, should next be taken, and the gum and sugar in this determined in the following manner:—

The *gum*, together with other matter, should be precipitated by subacetate of lead; the *sugar* remains in solution. The fluid part is to be separated from the solid: this is best effected by decantation, and the addition to the precipitate of small quantities of distilled water. After separation, the lead in each is to be got rid of by means of sulphuretted hydrogen, care being taken to use a water bottle, or some of the iron of the sulphate of iron used for obtaining the gas will pass into the solution. We have now obtained two clear liquids, the one holding chiefly gum in solution, and the other sugar.

These are next carefully evaporated—the sugar over a water bath, until it ceases to lose weight—the gum until it becomes nearly solid, when it should be treated with a little alcohol, dried and weighed. Finally, both the sugar and the gum should be incinerated, and the ash deducted.

Another portion of the porter, equal to the above, should be evaporated to dryness, and the weight of the extract determined; this should afterwards be burnt, the ash weighed, and, if necessary, tested for salt and iron.

The several results thus obtained are all to be calculated to the imperial gallon of 70,000 grains.

The taste of the ash is usually sufficient to betray the presence of *salt*, and its colour that of *iron*. From experiments made, we have ascertained that when sulphate of iron is present in porter, in as small a quantity as two grains to the nine gallons, the well burned ash of the extract will be found to be more or less coloured with the red oxide of iron. This is a very delicate means of determining the presence of iron in porter; and if iron in the above small quantity be found in it, there will be every reason for suspecting that sulphate of iron has been added to the beer; for the ash of genuine porter extract is never in the slightest degree coloured, but is always, when well freed from carbonaceous matter, either white or greyish white.

On the Detection of Bitters, Carminatives, &c.

The detection of many organic substances sometimes employed in the adulteration of porter and beer is, in most cases, a matter of extreme difficulty, and in others it is altogether impossible in the present state of science.

The following is the general method of proceeding for the discovery of the *bitters*, *carminatives*, and *acrid substances* employed: —

The extract of about 3000 grains of the porter or beer is to be treated with boiling alcohol, the alcoholic decoction is to be evaporated, and the extract tasted; the presence of many of the articles used will be sufficiently apparent by the taste. This is especially the case with the hot, pungent, and acrid substances used, as well as most of the bitters.

On the Detection of Cocculus Indicus.

One of the most injurious of the substances added to beer is the extract prepared from the seeds or berries of *cocculus indicus*. Its detection in beer, and especially in porter, is attended with very great difficulty; and in many cases, when employed in small quantities, it cannot be discovered by any known means. Dr. Herapath has recently published the results of some experiments, instituted with the view of determining the presence in beer of *picrotoxin*, the active and poisonous principle of cocculus indicus. He directs that the beer or porter should be first treated with excess of acetate of lead, so as to throw down all gum and colouring matter. The clear liquor is then to be separated by filtration, and the excess of lead precipitated by sulphuretted hydrogen. After standing for some time, or boiling so as to get rid of uncombined sulphuretted hydrogen, it is to be filtered again. The liquor, thus obtained, is to be evaporated at a moderate temperature until it becomes rather thick, and then treated with a little pure animal charcoal. After standing for some time, the charcoal is collected on a filter, washed with very little water, and dried at a steam heat. The charcoal contains the picrotoxin, which may be separated by boiling with a little pure alcohol, filtering, and evaporating to dryness on slips of glass. It is recognised by its forming plumose tufts of acicular crystals, or else oat-shaped forms.

M. Lassaigne has stated that *picric acid* is sometimes used to impart a bitter taste to beer and porter, and that it may be thus detected. He finds that this substance is not precipitated by subacetate of lead, which throws down most of the other colouring matters of beer, as well as the bitter principle of hops, and also that it is not absorbed by common bone charcoal thoroughly purified by acids. By means of one or other of these substances, he succeeds in obtaining a tolerably pure solution of picric acid. M. Lassaigne states that while pure beer is almost entirely decolourised by either subacetate of lead or purified bone charcoal, beer adulterated with the one twelve-thousandth or even the one eighteen-thousandth part of picric acid, remains of a yellow citron colour. Supposing the beer to contain a still more minute quantity of picric acid, it must, subsequent to the use of one or other of the above substances, be evaporated until the yellow citron colour is produced. It is possible that by the above method picric acid might be detected in poor and pale beers, but we very much doubt whether it would be successful in the case of London stout and porter, which are not entirely decolourised by either subacetate of lead or purified charcoal.

The presence of cocculus indicus may sometimes be determined by the effects, produced upon animals, birds, and fishes, of the alcoholic extract of the beer containing that narcotic.

The process for the detection of *strychnine* in beer will be found described under the head of Ale, and that for *opium* in organic mixtures under that of Cigars.

On the Detection of the Adulterations of Hops.—The several substances elsewhere enumerated as having been discovered in hops, may all be readily discerned frequently by the eye alone, and invariably by the microscope. The structure of *cardamom seeds* or *grains of paradise*, which is the article most frequently employed, will be found described and figured under the head of Curry Powder.

On the Detection of the Adulterations of Malt.—The admixture of unmalted with malted barley may be discovered on a careful general, as well as microscopical, examination of the grains; the grains of malt are white, more friable, and sweeter than those of raw barley, and the cellulose is ascertained by means of the microscope to have become destroyed. See p. 502.

It having been proved that beer is enormously adulterated, let us now inquire how far the Excise protects the revenue in the case of this article.

As has been shown, *malt* and *hops*, the ingredients used in brewing beer, are both adulterated, as is also the *beer* itself.

It appears from the evidence of Mr. Phillips, already quoted, that the Excise, with its 70 chemists and 4000 inspectors, in the course of twelve years, have examined only 40 samples of *hops*, of which 35 were adulterated.

With regard to *malt*, the Excise is in a state of happy ignorance, as appears from the following remarks of Mr. Phillips:—

Mr. Villiers. "What information can you give us respecting malt?"—"The fact is, we have been in some difficulty about that, and I believe we have arrived at a means by which we can detect any mixture. It is possible we may have been defrauded of malt duty by the mixture of grain; some traders assert we have largely, but I cannot say of my own knowledge."

"What would be the nature of the mixture?"—"Chiefly barley, I suppose."

The Excise is but little better informed respecting *beer*. Of 1139 samples examined by the Excise in twelve years, taken, when about to be exported, from vessels for the purpose of ascertaining their gravity so that the drawback might be allowed, that scientific body succeeded in discovering adulteration in only twelve samples.

Such is a summary of all that the scientific department of the Excise has been able to effect in discovering adulterations in hops, malt, and beer.

The Excise duty on malt since the 5th of July, 1856, is 2*s.* 8*d.*, and 5 per cent. thereon per bushel. During the war, from May, 1854, to 5th July, 1856, it was 4*s.* per bushel.

Since the 14th of August, 1855, malt made under certain regulation has been free of duty for distillation, which will account for the falling off in quantity in Scotland and Ireland particularly.

The quantities of *malt* retained for home consumption were, in—

	1853.	1854.	1855.	Nine Months of 1856.
	Bushels.	Bushels.	Bushels.	Bushels.
England - - -	36,198,272	31,863,739	30,195.520	21,018,819
Scotland - - -	4,163,830	3,411,511	2,366,407	684,073
Ireland - - -	1,630,076	1,537,477	1,317,454	861,182
United Kingdom - -	41,992,178	36,812,727	33,879,381	22,564,074

The Excise duty on *home grown hops*, imposed at different times and levied as the old and new duty, is together 2*d.* per lb., and 5 per cent. thereon.

Foreign hops pay a Customs' duty of 45*s.* per cwt.

Foreign hops imported in 1854, 119,040 cwts.; in 1855, 24,662 cwts. Entered for home consumption in 1854, 102,100 cwts.; 1855, 39,020 cwts.

The quantities of *home grown* hops that paid Excise duty, and were retained for home consumption, were (very varying according to the crops):—England, in 1853, 30,954,502 lbs.; in 1854, 9,293,992 lbs.; in 1855, 82,368,306 lbs.; in 9 months of 1856, not known, the duty being all charged in the last 3 months of the year. Scotland and Ireland, none.

Duty on *cocculus indicus*, 5*s.* per cwt.; extract of ditto, 20 per cent. *ad valorem.* Imported in 1854, 1,809 cwts.; in 1855, 430 cwts. Retained for home consumption in the first of these years, 161 cwts.; and in the second, 44 cwts.

Duty on *grains of paradise*, 15*s.* per cwt.; extract of ditto, 20 per cent. *ad valorem.* Imports in 1854, 249 cwts.; in 1855, 299 cwts. Home consumption in the corresponding years, 300 cwts. and 245 cwts.

Duty on *nux vomica*, 2*s.* per cwt.; extract of ditto, 20 per cent. *ad valorem.* Imports in 1854, 370 cwts.; in 1856, 2185 cwts. Home consumption, 60 and 31 cwts. Extract of *nux vomica* imported and retained for consumption in 1854, 4 cwts.; and in 1855, 5 cwts.

Beer and ale of all sorts, mum, spruce, pay duty on importation of 1*l.* per barrel.

ALE, AND ITS ADULTERATIONS.

The adulterations of ale are for the most part the same as those of porter and beer; that is, their strength is often reduced by *water;* and the majority of substances enumerated under the head of porter, as *bitters*, *carminatives*, *sulphate of iron*, &c., are used to restore apparently the reduced strength and flavour of the ale.

The alleged adulteration of ale with which our attention has been more particularly occupied, is that by *strychnine.* The following are the circumstances which induced the Editor of "The Lancet," Mr. Wakley, to undertake, through the author, a very extensive and rigorous inquiry into the subject.

In the year 1850, a Report came before the public, in which it was asserted that the deadly poison, strychnine, is commonly employed by brewers in the manufacture of "bitter beer" or "pale ale."

The following was the origin and foundation of this Report:—

In the course of a lecture delivered at the "Conservatoire des Arts et Métiers," M. Payen is asserted to have stated that strychnine was prepared in large quantities in Paris, and that the French authorities had ascertained that it was destined for England, it being employed in the manufacture of the celebrated bitter beer of that country.

This statement, after having appeared in some of the French papers, and amongst others in the "Constitutionnel," attracted the attention of some English journalists, who commented at some length upon it, incautiously treating the assertion as though its truth had been fully ascertained. At length the injurious statement made its way into the columns of "The Times" newspaper, and thus became universally disseminated.

It was impossible for the brewers of bitter beer, the preparation of which is confined to a small number of persons, to pass by without notice so grave a charge, and one so immediately affecting their interests. Accordingly the two chief firms, those of Messrs. Allsopp and Sons, and Messrs. Bass and Co., lost no time in publicly denying, in the most unequivocal terms, that strychnine, or any other deleterious substance, was ever employed by them in the manufacture of their beer.

These celebrated brewers suggested that their bitter beer should be subjected to a searching chemical and microscopical examination, and expressed their willingness to place the inquiry in the hands of "The Analytical Sanitary Commission." They offered to throw open their breweries, stores, &c., in the most complete and unreserved manner, and afford every facility for the fullest investigation.

Feeling that the subject was one of great importance; that it involved the public health to a great degree, and also the pecuniary interests of a trade, which, from its magnitude, had almost assumed a national character; that it also affected the judgment of the medical profession by whom the bitter beers had been so strongly recommended — Mr. Wakley ultimately agreed to undertake the inquiry upon the distinctly-declared condition that the results of the investigation and analyses, whether favourable or unfavourable to the reputation and quality of the beer, should be unreservedly and faithfully communicated to the public.

The importance of the subject will be duly appreciated when it is recollected that strychnia is the active principle of *nux vomica*, that it is remarkable for its intense bitterness and highly poisonous nature; one sixth of a grain having been known to prove fatal.

In order to put the statement to the test, 40 samples of bitter beer were subjected to analysis; twenty of the ale of *Messrs. Bass and Co.*, and the like number of samples of the ale of *Messrs. Allsopp and Sons.*

They were all found to consist of the products of *malt* and *hops*, and the constituents of *pure spring water;* no other ingredient of any kind being discovered, either organic or inorganic.

These samples were procured under circumstances which preclude the possibility of error, fallacy, or of preparation for the selection.

Many of the samples were taken from the stores of Messrs. Allsopp and Sons, and of Messrs. Bass and Co., at Blackwall and in the city, while others were procured from the principal agents and bottlers in the metropolis. In all cases, the utmost facility for investigation was afforded.

Some of the ales were destined for exportation, others for the home trade; whilst the dates at which they were brewed extended over a period of nearly two years. Not any sample of beer analysed was brewed *after* the promulgation of the statement concerning the employment of strychnia.

The stores at Blackwall belonging to Messrs. Bass and Co., and Messrs. Allsopp and Sons, each comprise many thousand butts, hogsheads, and barrels of bitter beer, which, arranged in tiers, and piled one above the other, extend over a space of several acres. The whole of these stores were thrown open to us, and liberty given to tap whichever cask we chose to select. In the case of the agents and bottlers the same liberty of choice was permitted, and in this manner butt after butt was opened and samples taken.

It should be observed that the casks are all branded with the names of the brewers, and that in most cases a register is kept, not only at the breweries and stores, but also at the agents' and bottlers', of the dates at which the different lots were brewed, all chance of mistake in the selection of the samples being thus obviated by reference to the marks and registries.

Under the above circumstances, and after the most scrutinising examination, microscopical, chemical, and physiological, we have failed to detect the smallest atom of strychnia, or, indeed, of any other ingredients than the products of malt and hops, and the constituents of pure spring water.

Unknown to, and wholly independent of ourselves, Messrs. Graham and Hoffman, at the request of Messrs. Allsopp and Sons, subjected several samples of their bitter beer to analysis. In their published report, it is stated that they failed to discover the slightest trace of strychnia.

Those gentlemen likewise placed themselves in communication with M. Payen, with whom the report was stated to have originated, in order to ascertain from himself the exact nature of the statement advanced by him.

It appears that the charge made by M. Payen was founded on information obtained by M. Pelletier, the celebrated preparer of quinia and other alkaloids, in France, who at one time received an order for a large quantity of strychnia, the destination of which was at first unknown to him, but which he afterwards found was exported to England, and used, so he informed M. Payen, to complete the bitterness of certain kinds of beer.

"We have reason to know," write Messrs. Graham and Hoffman, "although it is not stated by M. Payen, that these remarks of Pelletter refer to a period of ten or twelve years past; and further, although not informed of the amount of the order, we have good authority to state that fifty or a hundred ounces would have been considered a large order for strychnia at that time. The calculation already given shows how utterly insignificant such a supply of strychnia would be for its imagined application in the pale ale breweries. It is likewise known that the manufacture of strychnia has not been on the increase in France of late years."

Finally, M. Payen expressed his regret that he had ever said the fraud *appeared* to have been practised; although, at the time, he accompanied this observation with the further remark that *the falsification had no doubt ceased.*

M. Payen excused the statement made by him, on the ground that he did not originate it, and that the charge had been made public in the year 1850, in a French work treating of the Adulterations and Falsifications of Food. We have procured the publication in question, and find that it refers to the matter rather as a vague and uncertain report, than as a distinct allegation of the use of strychnia by English brewers; the author concluding his remarks on the subject in the following words: — "We hasten to say that this sophistication, like the preceding, is far from being based upon ascertained facts." *

The following are the concluding paragraphs of the Report of the Analytical Sanitary Commission of "The Lancet" on the subject: —

"From the pure and wholesome nature of the ingredients employed, the moderate proportion of alcohol present, and the very considerable quantity of aromatic anodyne bitter, derived from hops, contained in these beers, they tend to preserve the tone and vigour of the stomach, and conduce to the restoration of the health of that organ when in a state of weakness or debility.

"These bitter beers differ from all other preparations of malt in containing a smaller amount of extractive matter, thus being less viscid and saccharine, and consequently more easy of digestion: they resemble, indeed, from their lightness, *a wine of malt* rather than an ordinary fermented infusion; and it is very satisfactory to find that a beverage of such general consumption is entirely free from every kind of impurity.

"The admirers, therefore, of the bitter beer, manufactured by the celebrated brewers we have mentioned, may enjoy with advantage this, their favourite beverage. The report so commonly circulated, that it contained a deadly poison, was a severe reflection on the sagacity and judgment of the members of the medical profession, because it is perfectly well known that 'bitter beer or pale ale' first acquired and afterwards maintained its general celebrity in consequence of the universal recommendation of our profession — a recommendation which is now found to have had the best possible foundation."

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* Dictionnaire des Altérations et Falsifications des Substances Alimentaires, &c., p. 118.

It may be well, before proceeding to describe the tests, to consider how far the statement made, that strychnia is employed in the preparation of bitter beer, is consistent with probability. In order to form an opinion on this point, it is necessary to obtain clear ideas of the quantity of this substance necessary to impart bitterness to a given bulk of fluid, to determine the chemical condition in which it exists in beer, and to ascertain the amount of strychnia which may be introduced into the system, with safety to health and life. With respect to its bitterness, we find that one grain only of strychnia imparts a decided and persistent bitterness to at least 40,000 grains of water, or upwards of half a gallon; but the taste of the same quantity of strychnia is perceptible when diluted with 420,000 grains, or six gallons of water.

But it must be remembered that most beers contain free acetic acid in variable amount, and that, therefore, strychnia added to beer usually becomes converted into acetate of strychnia. Now this salt, although very bitter, is less so than strychnia itself; consequently, a larger amount of the combined alkaloid is necessary to impart the same degree of bitterness.

We have ascertained that not less than three grains of acetate of strychnia are needed to give a persistent and suitable bitterness to half a gallon of water; it is therefore evident that not less than one grain and a half of strychnia in combination with acetic acid would be required to impart such a degree of bitterness to the same quantity of beer as to render its use in the preparation of bitter beer a matter of any moment. Now a quantity of strychnia so considerable as this could not be taken in beer consistently with safety, or even without danger to life. Were the quantity present in beer much below this, its use would still be attended with the greatest danger, since there is much reason to believe that this poison, like digitalis, colchicum, and certain other active vegetable products, is liable to be retained in the system, and to accumulate in it to such an extent, as at length to give rise to the tetanic spasms and other consequences symptomatic of poisoning by strychnia.

From all these considerations, therefore, we conclude that the statement made concerning the use of strychnia in beer, under any circumstances, is scarcely consistent with probability.

On the Detection of Strychnine.

We now come to treat of the means by which the presence of strychnia in beer may be determined.

While chemical science, in its present condition, fails to detect many compounds derived from the organic kingdom, it is fortunate that this is not the case with the majority of the more deadly vegetable substances, as prussic acid, morphia, nicotina, brucia, and also strychnia.

Tests for Strychnine.—Strychnine, or strychnia, is met with in two states—the one impure, the other pure.

In its impure condition, it is in combination with another vegetable principle, termed brucia, and for which there exists a very characteristic chemical test.

Commercial strychnia is very commonly impure, being admixed with a greater or less amount of brucia; much, however, of the strychnia manufactured contains very little of this principle, and is even frequently entirely destitute of it, so that no reliance, for the detection of strychnia, can be placed upon this contamination, since it is not constant. The principal test for brucia, and indirectly for strychnia, when the two occur together, is nitric acid, with which reagent a blood-red colour is developed.

For the alkaloid in its *pure* state there are likewise appropriate and most satisfactory tests.

The first and chief of these was proposed in 1843 by Marchand*, who showed that if a small quantity of strychnia be rubbed with a few drops of concentrated sulphuric acid, or oil of vitriol, containing a very minute proportion of nitric acid, no change of colour would ensue; but that on the addition of a small quantity of the puce-coloured oxide of lead, or even of litharge, a beautiful violet colour is immediately developed, which quickly changes, first to a red, and then to an orange tint.

A modification of this test was subsequently proposed by Mack†, who suggested the substitution of peroxide of manganese for the oxide of lead. In this case precisely the same changes take place, and the same development and play of colours is produced.

Again, Otto‡ has suggested a further modification and improvement of the test by the employment of chromate of potash.

Lastly, Mr. Thompson recommended, in 1849, the use of bichromate of potash.§

One or two drops of strong sulphuric acid are to be allowed to fall on a minute quantity of strychnia, and in this a small fragment of bichromate of potash should be placed, around which a beautiful violet colour will be rapidly and continuously formed, so long as any of the strychnia or bichromate of potash remains undissolved and unacted upon.

The whole of these tests are exceedingly delicate and satisfactory—the last one particularly so; and by it so minute a quantity as the one thousandth of a grain of pure strychnia may be detected. The colours developed are the same whichever reagent be employed, but the tints are seen to the greatest advantage when the chromate or bichromate of potash is used, on account of the solubility of these salts.

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* Journal de Pharmacie et de Chimie, 3me Series, tom. iv. p. 200., 1843.
† Buchner's Repertorium, second series, vol. xliii.
‡ Pharmaceutisches Central-Blatt, Dec. 30. 1846.
§ Pharmaceutical Journal, vol. ix. p. 21.

The reagents noticed all act in the same way—namely, by parting with oxygen, which passes to and oxidates the strychnia.

The advantage of the bichromate of potash over the chromate, is attributable to the much greater quantity of oxygen contained in it.

The identification of strychnia, when obtained in a separate and crystallised state, is therefore perfectly conclusive.

Analysis of Beer for Strychnine.—When, however, we come to operate upon a dense and complex liquid, such as beer, the difficulties are somewhat enhanced, since it is necessary to obtain, in a separate form, the strychnia dissolved in it. This object may be effected in at least three ways. The first method of separation is as follows:—

Half a gallon of the beer is to be evaporated to dryness in a water-bath; the extract is then to be treated with about ten or twelve ounces of alcohol, the mixture being occasionally stirred with a glass rod. The alcohol dissolves out the strychnia, and takes up scarcely anything else except some colouring matter. The alcoholic solution is then to be filtered, treated with a sufficient quantity of liquor plumbi diacetatis, about two drachms, filtered, treated with a few drops of dilute sulphuric acid, again filtered, evaporated to dryness, and the residue then tested with any of the reagents above described.

The employment of acetate of lead is rendered necessary to effect the separation of the small quantity of organic matter taken up by the alcohol, and the sulphuric acid is required in order to get rid of any excess of lead.

The same object may be better attained in the following manner:—

In place of using alcohol, boil the extract with spirits of wine, filter, distil off the spirit, add a small quantity of solution of potash, about 40 drops, to the aqueous residue, and shake up with about an ounce of ether; this will take up the strychnia, and being lighter than water, will float on the surface, leaving the impurities in the water beneath. Lastly, the ethereal solution is to be evaporated, and the residue tested.

Another method of extraction is by means of animal charcoal. The extraordinary power possessed by this substance of absorbing gases and various other bodies, especially the active principles of vegetables termed alkaloids, is well known; and of this property advantage may be taken in the present instance.

From two to three ounces of animal charcoal are to be diffused through half a gallon of beer, and allowed to digest in it with frequent agitation from eight to twelve hours. The beer is to be filtered, when it will be observed that it has lost much of its colour and a portion of its bitterness; the charcoal, the whole of which should be collected on the filter, is then to be boiled with ten ounces of spirit of wine; and either of the plans described above may be adopted for obtaining the strychnia in a state of purity.

As the process of evaporation is one of considerable time and trouble, and as it is difficult to obtain a perfectly colourless residue in this way, the last method proposed for isolating the strychnia will be found the most convenient, as well as expeditious.

The two methods of purification may even be combined, and the potash and ether may be added to the aqueous residue after the employment of the solution of lead and sulphuric acid, and in this way a very pure ethereal solution may be obtained. Of the two plans, the necessary precautions being observed, the first is perhaps the best.

Whichever proceeding for the extraction and purification of the strychnia be followed, several precautions are required.

If charcoal be employed for the extraction of the strychnia, it is not simply sufficient to add the charcoal to the beer, but both before and during filtration the beer must be well shaken several times.

If the method of purification by means of ether and potash be adopted, the spirit of the spirits of wine used to separate the strychnia from the charcoal should be entirely distilled or evaporated off, which may be known to be the case when the vapour evolved ceases to smell spirituous, and to be pungent. If this precaution be not observed, the ether, in place of floating, will combine with the water and spirit.

The ether employed should be strong sulphuric ether, and it should not only be well shaken, with the aqueous residue, more than once, but should be allowed to remain in contact with it for about half an hour, so that it may have time to dissolve out the strychnia.

In adding the potash care must be taken lest too little or too much be employed; if too little be used, some of the organic matter will remain in suspension; and if too much the aqueous solution will become darkened.

If the plan of purification with acetate of lead and sulphuric acid be practised, the lead must be added until it occasions no further precipitate, and the sulphuric acid also, until the insoluble sulphate of lead ceases to fall.

When it is remembered that concentrated sulphuric acid darkens, and even chars organic substances of all kinds, the necessity for a complete separation of the organic impurities will become apparent.

A green colour in the course of a minute or two almost constantly forms around the fragments of bichromate of potash, even when strychnia is not present, and this takes place very quickly indeed if any ether, sugar, or organic matter remains on the glass. It is possible that this colour, formed by the green oxide of chromium which becomes liberated, might be erroneously regarded as an evidence of the presence of strychnia.

We refer to all these particulars because unless pointed out they are calculated to lead, as they have more than once done with ourselves, to embarrassment and disappointment.

Before proceeding to analyse the samples, preliminary experiments may be made with beer to which has been purposely added from half a grain to a grain of strychnia to a gallon of beer; we found that we could invariably succeed in detecting, by the methods indicated, the presence of the poison in these minute quantities.

We thus perceive how conclusive are the tests employed for the detection of strychnia.

The following process by Mr. Rodgers for the detection of strychnia in the animal tissues was published some months back in "The Times." It is equally applicable for the discovery of that alkaloid in beer:—

"The tissues of the body are rubbed with distilled water in a mortar to a pulp, and then digested after the addition of a little hydrochloric acid in an evaporating basin, then strained and evaporated to dryness over a water bath; digest the residue in spirit, filter, and again evaporate to dryness; treat with distilled water acidulated with a few drops of hydrochloric acid, and filter; add excess of ammonia, and agitate over a tube with chloroform: the strychnine in an impure condition is entirely separated with the chloroform. This chloroform solution is to be carefully separated by a pipette, and poured into a small dish, and wiped to dryness; the residue is moistened with concentrated sulphuric acid, and heated over a water bath for half an hour; water is then added and excess of ammonia, again agitated with chloroform, and the strychnine will be again separated by the chloroform now in a state of sufficient purity for testing, which can be done after evaporating a few drops on a piece of white porcelain."

But we need not confine ourselves to chemistry in order to obtain evidence of the presence of strychnia in organic fluids, as physiology will disclose the fact almost equally well.

One gallon of beer, to which a grain of strychnia had been purposely added, was evaporated to an extract; this was boiled for nearly an hour in a mixture of ether and alcohol; the solution, after filtration, was evaporated, and the residue, of a soft consistence, was administered as a pill to a small rabbit. In the course of two minutes the animal became affected with convulsive twitchings; these were almost immediately succeeded by a paroxysm of convulsions, in which the animal threw himself on his side, the head and neck being thrown back, the hind and fore legs extended and drawn backwards. The first paroxysm was rapidly followed by others, and in less than five minutes after the administration of the pill the rabbit was dead, it having exhibited the peculiar symptoms which characterise poisoning by strychnia.

GIN, AND ITS ADULTERATIONS.

Gin was made originally in Holland, in the distilleries of Schiedam, and hence that which is brought to this country is termed Hollands Gin. At one time, when the duty was low, it used to be largely imported, but owing to the high rate of duty levied upon it for some years past, which was, until 1846, 1*l.* 2*s.* 10*d.* per imperial gallon, and since that period has remained at 15*s.*,—but little now reaches this country.

In Holland it is made solely from unmalted rye and barley malt, rectified with juniper berries. In Britain, gin is for the most part obtained from a mixture of malt and barley, molasses and corn being sometimes employed, particularly when there is a scarcity of grain, and it is usually flavoured not only with juniper berries, but with certain other substances, most of which are aromatics, and amongst which are the following: coriander, cardamom, and caraway seeds, grains of paradise, angelica root, calamus root, crushed almond cake, liquorice powder, and orange peel. These ingredients, variously combined, form what are known in the trade as "gin-flavouring."

Pure gin should consist, as does Hollands, solely of rectified corn spirit flavoured with juniper berries.

On the Adulterations of Gin.

Gin is commonly diluted or adulterated with large quantities of *water*.

But since the addition of water to gin renders the mixture whitish and turbid, by occasioning the precipitation of the oily and resinous matters of the juniper and other substances employed to flavour the gin previously held in solution by the spirit, it becomes necessary to have recourse to certain substances to "fine" the gin, as it is termed, that is, to restore the transparency of the spirituous mixture.

The substances more commonly employed for this purpose are *alum*, *subcarbonate of potash*, and occasionally *acetate of lead*. Alum dissolved in water is first added to the weakened spirit, and then a solution of subcarbonate of potash. The whole is stirred together, and left at rest for twenty-four hours. The alumina of the alum, precipitated by the subcarbonate of potash, acts "as a strainer upon the milky liquor, and carries down with it the finely divided oily matter, which produces the blue colour of the diluted liquor."—*Accum.*

Roche alum is sometimes used for clarifying spirituous liquors without any other addition.

"Another method consists in adding first a solution of subacetate of lead, and then a solution of alum. This practice is highly dangerous, because part of the sulphate of lead produced remains dissolved in the liquor, which it thus renders poisonous. Unfortunately this method of clarifying spirituous liquors, I have good reason to believe, is more frequently practised than the preceding method, because its action is more rapid, and it imparts to the liquor a fine *complexion*, or great refractive power; hence some vestiges of lead may often be detected in malt spirit."—*Accum.*

Another substance added to gin is *sulphuric acid.* Mr. Mitchell states that a mixture composed of alum, carbonate of potash, almond oil, sulphuric acid, and spirits of wine, is frequently added to gin. "This compound," he remarks, "not only fines the gin, but communicates to it the property of 'beading,' or hanging in pearly drops or beads on the sides of the glass containing it. When gin does this, it is generally supposed to be strong in proportion as it beads, and the above mixture communicates to weak gin that property, so that it will be evident gin can be considerably diluted with water, and yet, by the addition of the above, appear of its proper strength."

But opacity is not the only evil produced by the addition of water to gin; the strength and flavour of the gin are so reduced that it becomes necessary to add other substances to restore the qualities lost by dilution: these being *sugar* to sweeten it, and *cayenne*, in the form of *tincture of capsicum*, or *grains of paradise*, to give it pungency and apparent strength.

The flavour and properties of gin are further modified by the use of compounds known as "*gin flavourings.*"

These are composed of various cordial and aromatic substances, each distiller usually giving the preference to a formula of his own.

In Dr. Muspratt's "Chemistry"* will be found several receipts for gin flavourings, copied from the note book of an extensive spirit rectifier. Two of these are as follows:—

Plain or *London Gin* is made as follows:—

700 gallons of the second rectification.
70 lbs. German juniper berries.
70 lbs. coriander seeds.
3½ lbs. almond cake.
1½ lbs. angelica root.
6 lbs. liquorice powder.

For the manufacture of *West Country Gin*, known also as Plymouth gin, the annexed is the process given in Dr. Muspratt's work:—Introduce into the still 700 gallons of the second rectification, and flavour with—

14 lbs. German juniper berries.
1½ lbs. calamus root, cut; and
8 lbs. sulphuric acid.

This gin is much used in Cornwall, and particularly in the western counties of England; it is also used in making British Hollands, and in that case is mixed with about five per cent. of fine gin, reduced to twenty-two under-proof with liquor.

Amongst the ingredients enumerated in the other receipts, and not contained in those above given, are orange peel, calamus root, cassia buds, orris root, cardamoms, and grains of paradise.

In Shannon's work, "On Brewing and Distilling," we meet with the following instructions for reducing unsweetened gin, and for preparing and sweetening British gin:—

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* Chemistry, Theoretical, Practical, and Analytical.

" *To Reduce Unsweetened Gin.*

" A tun of fine gin	252 gallons.
Water	36 ,,
Which, added together, make	288 ,,
The *Doctor is now put on*, and it is further reduced with water	19 ,,
Which gives	307 gallons of gin."

" This done, let one pound of alum be just covered with water, and dissolved by boiling; rummage the whole well together, and pour in the alum, and the whole will be fine in a few hours.

" *To Prepare and Sweeten British Gin.*

" Get from your distiller an empty puncheon or cask, which will contain about 133 gallons. Then take a cask of clear rectified spirits—120 gallons—of the usual strength at which rectifiers sell their goods; put the 120 gallons of spirits into your empty cask.

" Then take a quarter of an ounce of oil of vitriol, half an ounce of oil of almonds, a quarter of an ounce of oil of turpentine, one ounce of oil of juniper berries, half a pint of spirit of wine, and half a pound of lump sugar. Beat or rub the above in a mortar. When well rubbed together, have ready prepared half a gallon of lime water, one gallon of rose water: mix the whole in either a pail or cask, with a stick, till every particle shall be dissolved; then add to the foregoing twenty-five pounds of sugar dissolved in about nine gallons of rain or Thames water, or water that has been boiled: mix the whole well together, and stir them carefully with a stick in the 133 gallon cask.

" To *force down* the same, take and boil eight ounces of alum in three quarts of water for three quarters of an hour; take it from the fire, and dissolve by degrees six or seven ounces of salt of tartar. When the same is milk warm, pour it into your gin, and stir it well together as before, for five minutes, the same as you would a butt of beer newly fined. Let your cask stand as you mean to draw it. At every time you propose to sweeten again, that cask must be well washed out, and take great care never to shake your cask while it is drawing."

But it appears there are other little practices, besides those connected with adulteration, which are sometimes had recourse to by retailers of spirits. Mr. Shannon, from whose work "On Brewing and Distilling" we have just quoted, gives the following advice and recommendations as to certain manipulations and particulars which should be observed in retailing spirits over the counter.

"When you are to draw a sample of goods to show a person that has judgment in the proof, do not draw your goods into a phial to be tasted, or make experiment of the strength thereof that way, because the proof will not hold except the goods be exceedingly strong; but draw the pattern of goods either into the glass from the cock, to run very small, or rather draw off a small quantity into a little pewter pot, and pour it into your glass, extending your pot as high above the glass as you can without wasting it, which makes the goods carry a better head abundantly, than if the same goods were to be put and tried in a phial.

"You must be so prudent as to make a distinction of the persons you have to deal with; what goods you sell to gentlemen for their own use who require a great deal of attendance, and as much for time of payment, you must take a considerably greater price than of others; what goods you sell to persons where you believe there is a manifest, or at least some, hazard of your money, you may safely sell for more than common profit; what goods you sell to the poor, especially medicinally, (as many of your goods are sanative,) be as compassionate as the cases require."

Results of the Analysis of Samples.

The following are the results of the analysis of *Thirty-eight* samples of gin:—

That the *strength* of the various samples ranged from 15,645 grs. to 34,160 grs. per imperial gallon; the per-centages ranging from 22·35 to 48·80 per cent.

It thus appears, that some of the spirits contained only half as much alcohol as was present in some of the other samples, and therefore that their commercial value was reduced to the enormous extent of more than one half; thus, supposing sample 2. to be worth 12*s.* per gallon, sample 35. would be worth less than 6*s.* per gallon. This variation in the strength of the spirits is doubtless principally attributable to dilution with water.

That the quantity of *sugar* ranged from 3 oz. 4 dr. 23 gr. to 13 oz. 4 dr. 13 gr. per gallon.

That *two* of the samples contained *oil of cinnamon*, or more probably of *cassia.*

That *seven* of the samples contained Cayenne pepper, some of them in very large quantity, so that the syrupy extract left on evaporation possessed a burning and fiery taste.

That in no case was *free sulphuric acid* detected; its absence being sufficiently shown, by all the samples being neutral to test paper.

That *most* of the samples contained combined sulphates, chiefly derived from the water and alum used in the adulteration and clarification of the gins.

In addition to the above adulterations, we have the authority of a gin distiller for stating that the practice of adding *sulphate of zinc*, or as it is commonly called, *white vitriol* or *white copperas*, to gin is very common. Here again, then, we have obtained evidence of the adulteration of gin in a manner calculated to prove injurious to health.

It is impossible to conceive of more scandalous adulterations of gin or other spirits than those by *Cayenne pepper* or *grains of paradise*, for they are almost equally hot and pungent. The introduction into the stomach of raw spirits is sufficiently destructive to health of itself, but the addition of such powerful and acrid substances as Cayenne and grains of paradise to spirit, forms a compound which no human stomach or system, however strong, can long withstand.

Although *sulphuric acid* was not present in any of the samples of London gin which we examined, it is yet, no doubt, sometimes employed, and this in large quantity. Dr. Muspratt states that it is so in West Country gin. If any sample of gin exhibit an acid reaction, the presence of sulphuric acid may be suspected, and it may be discovered simply by the evaporation at a gentle heat of a little of the gin, placed on the hob of a fireplace. As soon as all the spirit and water have been driven off, the sulphuric acid will act on the sugar, and quickly reduce it to a black carbonaceous mass.

The adulteration of gin with Cayenne pepper is mostly effected by means of tincture of capsicum, and it is practised in the majority of cases by the publicans themselves. We are acquainted at the present time with the name of a publican whom we have ascertained to make periodical purchases of tincture of capsicum. We know the chemist of whom he purchases it, and we have detected it in more than one sample of the gin sold by him to his customers at the bar.

We have often in the course of this work commented on what we conceived to be the remissness of the Excise authorities. Here is a gross adulteration of gin, commonly practised, and detectable in a ready and simple manner, by which the revenue is defrauded, and which is seriously detrimental to health; and yet we do not remember to have ever heard that the Excise had noticed it in any way, or taken any steps to put a stop to so iniquitous an adulteration.

The different kinds of spirits are obtained in a comparatively crude state from the grain by the distiller. They are afterwards submitted to purification by the rectifier, as well as procured of a higher strength. The impurity of raw spirits arises principally from the presence of a peculiar volatile oil, termed *fusil oil*, and possessing very deleterious properties. Of this oil, and of the method of freeing spirits from it, we meet with the following account in Ure's Dictionary*:—"Sometimes, after moist autumns, when damaged grain abounds, the alcohol distilled from its fermented wash contains a peculiar volatile body.

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* 4th Edition, vol. i. p. 30.

When we apply our nose to this species of spirits in its hot state, the volatile substance dissolved in it irritates the eyes and nostrils; it has very nearly the same smell as an alcoholic solution of cyanogen, as any chemist may discover by standing near the discharge-pipe of the refrigeratory worm of a raw-grain whisky still. Such spirits intoxicate more strongly than pure spirits of the same strength, and excite, in many persons, even temporary frenzy. It is a volatile fatty matter, of a very fetid odour, when obtained by itself, as I have procured it in cold weather at some of the great distilleries in Scotland. It does not combine with bases. At the end of a few months, it spontaneously decomposes in the spirits, and leaves them in a less nauseous and noxious state. By largely diluting the spirits with water, and distilling at a moderate temperature, the greater part of this oil may be separated. Part of it comes over with the strongest alcohol, and part with the latter runnings, which are called by the distillers strong and weak feints. The intermediate portion is purer spirit. The feints are always more or less opalescent; or become so on dilution with water, and then throw up an oily pellicle upon their surface. The charcoals of light wood, such as pine or willow, well calcined, and infused in sufficient quantity with the spirits prior to rectification, will deprive them of the greater part of that oily contamination. Animal charcoal, well calcined, has also been found useful; but it must be macerated for some time with the empyreumatic spirits before distillation. Another method of separating that offensive oil is to agitate the impure spirits with a quantity of fat oil, such as olive oil, or oil of almonds, to decant off the oil, and re-distil the spirits with a little water.

"Digestion and agitation with calcined magnesia for some time, followed by filtration and distillation, are also good means for improving the flavour of alcohol. The taste of the oil of grains is best recognised by agitation with water, whereby, on standing, the diluted spirit throws up a film of oil visible by reflected light. If the spirit be mixed with a few drops of nitrate of silver, and exposed for some time to sunshine, the oil will react upon the oxide of silver, and cause a brown tinge; but if there be no oil present, the spirits will remain limpid. If one part of hydrate of potash, dissolved in a little water, be mixed with 150 parts of spirits, and if the mixture be well shaken, then slowly evaporated down to 15 parts, and mixed with 15 parts of dilute sulphuric acid in a phial, to be then corked, there will soon exhale from the mixture a peculiar offensive odour characteristic of the quality and origin of the impure spirit, whether obtained from raw grain, from malt, from potatoes, rye, arrack, rum, brandy, &c. This excellent process may be used also for testing wines. Lime and alkalis always injure the flavour of ardent spirits of all kinds."

Dr. Taylor remarks of fusil oil, "that in small quantities it produces intoxication. I have experienced the effects of the vapour, and found them to be giddiness, accompanied with a feeling of suffocation and a sense of falling. Headache followed which lasted for half an hour."

"Two drachms of the oil killed a rabbit in two hours, three drachms in an hour, half an ounce in a quarter of an hour, and one ounce in four minutes."

Much of the unwholesomeness of spirit imperfectly rectified arises from its contamination with fusil oil.

On the Detection of the Adulterations of Gin.

Adulteration with Water.—The adulteration of gin with water may be determined in two ways, the one indirect and the other direct.

The *indirect* method is by estimating the quantity of alcohol contained in it. This is effected by the processes described below.

Method of Estimating the Quantity of Alcohol present in any Spirituous Liquid.

Saccharometers, &c.—There are several methods by which the amount of alcohol contained in any spirituous liquid may be determined with greater or less accuracy. One of the readiest of these means is to ascertain the specific gravity of the spirit by a specific gravity instrument for liquids. Of these instruments, many different kinds have been invented, with scales adapted to the range of the liquids for the determination of the density of which they have been constructed: thus we have *saccharometers*, *hydrometers*, *alcoholometers*, *specific gravity bottles*, &c.; but the principle on which these instruments are constructed is alike in all cases. By the *saccharometer* the amount of extractive matter in beer or other alcoholic liquid is ascertained.

Sykes' Hydrometer.—The instrument in general use for determining the specific gravity of spirituous liquids in this country is what is known as *Sykes' hydrometer.* It differs, however, from the ordinary hydrometer in the division of its scale, and also in the use of weights. The hydrometer is calculated to show the strength in spirit either above or below a certain fixed standard, denominated "*proof.*"* The stem of the instrument is graduated and subdivided, so as to meet the extremes of variation in the strength of the liquors examined by it.

Sykes' hydrometer is the instrument mostly used by the Excise, by brewers, distillers, and publicans.

Since the specific gravity of a spirituous liquid is subject to great variations at different temperatures, it is necessary that the temperature of the spirit at the time of taking its weight should be noted, and corrections made for this by means of certain tables which have been constructed for the purpose. The standard temperature at which the specific gravity of the spirit is usually taken is 60° Fahrenheit.

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* "This liquor not being spirit sweetened, or having any ingredient dissolved in it to defeat the strength thereof, of the temp. of 51° Fahr., weighs exactly $\frac{12}{13}$ parts of an equal measure of distilled water."

The specific gravity test for determining the amount of alcohol present in liquids is applicable only when they are free from any solid substance, as extractive, sugar, &c., the presence of which, by affecting the weight, of course influences the specific gravity. When, therefore, any liquid contains saccharine or other solid matter, it is requisite that the spirit should be separated by distillation, and that the specific gravity of the alcohol thus obtained should be taken. Where strict accuracy is required, it will be necessary to have recourse to distillation in almost all cases, since there are but few spirits which do not contain more or less solid matter.

Centesimal Alcoholometer.—A considerable improvement on Sykes' hydrometer is the instrument, invented by M. Gay Lussac many years since, called the *centesimal alcoholometer.* This instrument, when immersed in any spirituous liquid at the temperature of 15° centigrade, equal to 59° Fahr., at once indicates the quantity of alcohol by measure present. As its name implies, the stem is divided into a hundred parts or degrees, and is so contrived that each degree represents one hundredth part of anhydrous or pure alcohol; thus the point at which it floats, when immersed in any spirit at a certain temperature, indicates exactly the per-centage of absolute alcohol contained in that spirit. The great value of this instrument is, that it shows at once the per-centage of alcohol, all subsequent calculations, with the loss of time involved, and the possibility of inaccuracies, being thereby avoided.

Ebullioscope.—Another instrument, constructed on a totally different principle to the ordinary densimeters, is the *ebullioscope* or *ebullition alcoholometer.* This instrument is based upon the fact that the boiling point of spirituous liquids varies according to the amount of alcohol contained in them (a discovery made by the Abbé Brossard-Vidal, of Toulon), without its being essentially modified, like the other instruments, by the presence and nature of any solid ingredients which may be contained in them.

There are several forms of this instrument; there is the original one of M. Brossard-Vidal, and the modifications by M. Conaty, by MM. Lerebours and Secretan, and by Dr. Ure.

The mercurial thermometer used in the modification of the instrument by MM. Lerebours and Secretan is graduated centesimally in degrees, which correspond to those of the centesimal alcoholometer of M. Gay Lussac, and its bulb is plunged in the liquid to be proved. The liquid is carefully heated by means of a spirit lamp, the flame of which should not be strong, lest it occasion the too rapid ebullition of the spirit. Before using the instrument, it is necessary to determine the boiling point of pure water, and the barometrical pressure of the atmosphere on the day on which the experiments are made.

In Dr. Ure's modification of the instrument, the scale is adapted to that of Sykes' hydrometer.

It would be of the greatest possible advantage — would save immense time and trouble — if densimeters of all kinds were revised, and were reduced to one uniform centesimal scale, as is done, in fact, in many of the instruments in use on the Continent.

The ebullioscope is probably sufficiently accurate in the results which it furnishes to afford considerable service to the distiller, the rectifier, the wine maker, and the brewer; but is certainly not so where strict analysis is required.

Dr. Ure's modification of the ebullioscope, together with a full description of its principles and application, may be obtained of Mr. Joseph Young, Little Tower Street.

Alcoholometric Dilatometer. — Another instrument which has been invented for the determination of the proportion of alcohol in spirituous liquids is the *alcoholometric dilutometer* of M. Silbermann. By this instrument, the amount of spirit is determined by the dilation of the spirituous liquid at various temperatures.

Specific Gravity Bottle.—A still more accurate method of determining the quantity of alcohol contained in spirituous liquids from their specific gravity, is by means of *the specific gravity bottle.* In using this, the same precautions with regard to temperature and the presence of any solid substance in the spirit must be observed.

For ordinary purposes, in the hands of manufacturers and dealers, of all the instruments for determining the strength of spirituous liquors, the centesimal alcoholometer of M. Gay Lussac is the safest and best, and, next to that, Sykes' hydrometer. But the chemist, when any solid matter is contained in the liquid to be examined, should, in all cases, separate the alcohol by distillation, and determine its amount from the distilled liquid, and this is the method by which we have proceeded in the determination of the alcohol contained in the samples of gin the results of the analyses of which we have made known. The exact steps to be adopted are as follows: —

The temperature of the several spirits is to be reduced in all cases, by means of a solution of ice and salt, to one uniform degree — viz., 60° Fahr., and its specific gravity at that temperature determined by means of the specific gravity bottle; 1500 grains by measure are next distilled, and the distillation carried nearly to dryness; the distilled liquor is brought to 60° Fahr., weighed, and its specific gravity again taken. These particulars being determined, the per-centage of alcohol is ascertained by the alcoholometrical table of Tralles. (See p. 536.)

The third column of this table exhibits the differences of the specific gravities which give the denominator of the fraction for such densities as are not found sufficiently near in the table, and the difference of their numerators is the next greatest to the density found in the table; for example, if the specific gravity of the liquor found for 60° Fahr. = 9·605 (the per-centage will be between 33 and 34), the difference from 9·609 (which is the next greatest number in the table) = 4, and the fraction is $\frac{4}{13}$, therefore the true per-centage is

$33\frac{4}{13}$, or, decimally, thus, 33·31. In order to ascertain the amount, by volume, of alcohol in the gin or other spirit under examination,

ALCOHOLOMETRICAL TABLE OF TRALLES.

Alcohol* in 100 Measures of Spirit.	Specific Gravity at 60° Fahr.	Difference of the Specific Gravity.	Alcohol in 100 Measures of Spirit.	Specific Gravity at 60° Fahr.	Difference of the Specific Gravity.
0	9·991	—	51	9·315	20
1	9·976	15	52	9·295	20
2	9·961	15	53	9·275	20
3	9·947	14	54	9·254	21
4	9·933	14	55	9·234	20
5	9·919	14	56	9·213	21
6	9·906	13	57	9·192	21
7	9·893	13	58	9·170	22
8	9·881	12	59	9·148	22
9	9·869	12	60	9·126	22
10	9·857	12	61	9·104	22
11	9·845	12	62	9·082	22
12	9·834	11	63	9·059	23
13	9·823	11	64	9·036	23
14	9·812	11	65	9·013	23
15	9·802	10	66	8·989	24
16	9·791	11	67	8·965	24
17	9·781	10	68	8·941	24
18	9·771	10	69	8·917	24
19	9·761	10	70	8·892	25
20	9·751	10	71	8·867	25
21	9·741	10	72	8·842	25
22	9·731	10	73	8·817	25
23	9·720	11	74	8·791	26
24	9·710	10	75	8·765	26
25	9·700	10	76	8·739	26
26	9·689	11	77	8·712	27
27	9·679	10	78	8·685	27
28	9·668	11	79	8·658	27
29	9·657	11	80	8·631	27
30	9·646	11	81	8·603	28
31	9·634	12	82	8·575	28
32	9·622	12	83	8·547	28
33	9·609	13	84	8·518	29
34	9·596	13	85	8·488	30
35	9·583	13	86	8·458	30
36	9·570	13	87	8·428	30
37	9·556	14	88	8·397	31
38	9·541	15	89	8·365	32
39	9·526	15	90	8·332	33
40	9·510	16	91	8·299	33
41	9·494	16	92	8·265	34
42	9·478	16	93	8·230	35
43	9·461	17	94	8·194	36
44	9·444	17	95	8·157	37
45	9·427	17	96	8·118	39
46	9·409	18	97	8·077	41
47	9·391	18	98	8·034	43
48	9·373	18	99	7·988	46
49	9·354	19	100	7·939	49
50	9·335	19			

it is necessary to proceed as follows: — In order to find the per-centage of absolute alcohol of 7·939 specific gravity in a sample of spirit, divide the number of grains distilled over by the specific gravity of the distilled spirit. Multiply this quotient by the per-centage according to Tralles, and divide this sum by the bulk of the original sample taken; the quotient is the per-centage. This per-centage multiplied by 700 gives the number of grains of absolute alcohol by volume in the gallon. The above comprise all the calculations necessary for arriving at this result. The following is a statement of the several sums: —

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* Anhydrous Alcohol of specific gravity 7·939.

1500 gr. by volume yield 1334·6 gr. by weight; sp. gr. ·9484;
per-centage, 41·62
The bulk of the distilled spirit is obtained by
As ·9484 · 1· :: 1334·6 : A
The volume of absolute alcohol obtained by
As 100· : A :: 41·67 : B
The per-centage by volumes in the sample by
As 1500 : B :: 100· : C = 39·09
To find the quantity of absolute alcohol in a gallon,
As 100· C : 700· D
the quantity required.

From the construction of Tralles' table, the per-centage of alcohol by weight may also be found — for instance, multiply the number representing the volumes of alcohol given in the table for any determinate specific gravity of the mixture by the specific gravity of the pure alcohol — that is, by 7·939, and the product is the number of pounds of alcohol in so many pounds, as the specific gravity multiplied by 100 gives. Thus, in the mixture, 9·510 specific gravity, there are 40 measures of alcohol; hence there are also in 95·100 lbs. of this spirit 7·939+40 = 31·756 lbs. of alcohol; and in 100 lbs. of the spirit of 0·9510 specific gravity 33·39 lbs. of alcohol are contained.

On the Presence of Sulphates in Gin.

The *direct* method of determining whether gin has been adulterated with water is by ascertaining whether the gin contains sulphates or not.

The addition of acid nitrate of baryta to gin which has not been adulterated with water, should not occasion any precipitation of sulphates, because the water contained in the spirit is all distilled. When, therefore, on the addition of the above reagent, a precipitate is thrown down, this is due either to the presence of free or combined sulphuric acid; if the latter, and there be no sulphate of zinc present, the sulphates are derived either from the water used for the dilution of the spirit, or from the alum employed for clarifying and beading it, so that, alumina being absent, the presence of sulphates affords in all cases a certain indication of the adulteration of gin with water.

Out of *Ten* samples of gin to which the baryta test was added, four turned slightly opalescent, but scarcely any deposition of sulphate occurred; while in six of the samples there was a decided, and in three a considerable, precipitation. These gins were likewise evaporated, the residues dissolved in a little distilled water, and the solution divided into two parts; to one the acid nitrate of baryta was added as before, when sulphate of baryta was thrown down in every case, and in most in great abundance. Through the other half of the solution sulphuretted hydrogen was passed; in not one instance was any white precipitate observed, from which the absence of zinc is to be inferred. These observations are important, because they afford us the means of judging of the adulteration of gin by the addition of water. Heretofore the presence of water has been inferred rather than proved, from the deficiency of alcohol in the spirit supposed to contain the water.

There is one only source of fallacy with which it is necessary that we should be acquainted. Supposing sulphuric acid to have been added to the gin, a precipitation would equally occur, although no water had been added, on the addition of nitrate of baryta. This fallacy may be guarded against by ascertaining in the first place whether the gin exhibits an acid reaction or not to test paper, and if it does, we must then proceed as directed in the article on Vinegar, for the determination of free and combined sulphuric acid.

Method of determining the Amount of Sugar in Gin.

This is readily determined in either of the two following ways: — The syrupy liquid contained in the retort after distillation should be removed and evaporated with a gentle heat, until the water has been driven off, and the sugar crystallised. Or a fresh weighed portion of the gin may be evaporated in the same manner, and the weight of the sugar furnished by it ascertained. The latter is the more accurate method, because the heat employed in distilling off the spirit not unfrequently modifies the sugar considerably, so that in all cases it will not crystallise properly.

Method of detecting the Presence of Capsicum, Grains of Paradise, and other fixed Acrid Substances in Gin.

The presence of these may usually be ascertained by simply tasting a portion of the syrupy extract left after distillation. The acrid principle of capsicum is a fixed one, and no part of it passes over during distillation. Of the two acrid principles contained in grains of paradise, one is volatile, and the other fixed. The taste of the fixed principle very closely resembles that of Cayenne pepper, but may be usually distinguished with a little care. The plant which furnishes Malaguetta pepper, or grains of paradise, is the *Amomum Grana Paradisi.*

On the Detection of Cinnamon or Cassia in Gin.

As the flavour of these depends upon the presence of essential oils, they, of course, readily pass off during distillation, and the extract, therefore, does not usually furnish any evidence characteristic of their presence. For the purpose of detecting these oils, the spirit should be gently evaporated, and at such a temperature as does not occasion the volatilisation of the oils, and their presence judged of by the smell and taste of the extract.

On the Detection of Cherry Laurel Water or Spirit of Almond Cake.

Distil the spirit nearly to dryness, add to the distilled liquid a little caustic potash, evaporate down to a small bulk; add a few drops of a solution obtained by dissolving protosulphate of iron in water, and exposing the so-made solution to the action of air for ten or twelve hours; a few drops of a solution of potash and a little hydrochloric acid must be now added, and if the liquid acquires a blue tinge, the spirit under examination has been flavoured with cherry laurel water or spirit of almond cake.

The reactions are as follow: — The hydrocyanic or prussic acid of the laurel water and almond cake, when the spirit is distilled, passes over, and on the addition of the potash is converted into cyanide of potassium; the addition of the salt of iron and hydrochloric acid occasions the formation of prussian blue, which is a ferrocyanide of iron.

A more delicate method is the following, first described by Liebig:— The liquid must be distilled as before, potash added, the bulk of the spirit reduced by evaporation; hydrochloric acid must next be added in slight excess, and then a drop of sulphide of ammonium, and the whole treated until colourless. A little perchloride of iron must now be added, when, if prussic acid be present, the liquid will become of a blood red colour.

The reactions are as follow: — The sulphocyanide of ammonium is formed by the reaction of sulphide of ammonium and hydrocyanic acid, and this, like other soluble sulphocyanides, strikes a blood-red colour with a persalt of iron.

On the Presence of Lead in Gin.

As we have seen, it is commonly stated that acetate of lead is employed in the clarification of adulterated gin; in order, therefore, to ascertain whether the metallic base of this salt is to be found in gin, eight ounces of *Ten different samples* were evaporated, the residues dissolved in a little distilled water, and sulphuretted hydrogen passed through them: in one case a decided brownish discolouration ensued; in some of the others, slighter discolourations were observed; but in none of the gins was lead discovered in the ashes treated with nitric acid and water, and tested with iodide of potassium. If lead was therefore, present in any of the samples, it was so only in traces.

The absence of lead may be explained in some cases even where it has really been used. The lead of the acetate would combine with the sulphates of the water, and the insoluble sulphate of lead would be precipitated; it is, therefore, only when the quantity of lead added is in excess of the sulphates, that it would be found in gin, and when sulphates are present in gin we may safely conclude that it does not contain lead.

On the Detection of Sulphate of Zinc in Gin.

The sugar, having been dried, and its weight determined, is to be re-dissolved in distilled water. Half of the solution is to be tested with acid nitrate of baryta for sulphuric acid, and the other half treated with sulphuretted hydrogen, by which means the zinc will be thrown down as a white hydrated sulphuret, from which, if sufficient of the spirit be used, the metal itself may be separated. We give these directions for the detection of this salt, because it is very probable that it is sometimes used to clarify adulterated gin.

Gin, as already stated, is made by rectifying corn spirit, with the addition of flavouring materials. The Excise duty is paid on the corn spirit, now 8*s*. per gallon, hydrometer proof. The duty in Scotland is now the same as that in England, and in Ireland is 6*s*. 2*d*. per gallon.

The quantities of spirits manufactured in the *United Kingdom*, charged with duty, were—

	In 1854.	In 1855.	In Nine Months of 1856.
	Galls.	Galls.	Galls.
England alone - - - -	10,889,611	10,384,100	6,638,429
Scotland „ - - - -	6,553,239	5,344,319	5,117,050
Ireland „ - - - -	8,440,734	6,228,856	4,816,057
Total - - -	25,883,584	21,957,275	16,571,536

This return merely shows *where* the duty was *paid*, not where the spirits were actually consumed.

The return for 1855 is six days short of the year. This is the case through all the returns, as the financial year is altered.

The above quantities are exclusive of exportation, which has recently been very large.

RUM, AND ITS ADULTERATIONS.

Rum is the spirit obtained by the fermentation and distillation of the refuse juice of the sugar cane, chiefly molasses.

It owes its distinctive smell and taste to a peculiar volatile oil.

It differs from other spirits in its tendency to cause perspiration; for this reason it is often used by those suffering from colds and coughs.

The adulterations of rum very nearly resemble those of gin, and they consist chiefly in the addition of *water*, whereby its strength is reduced; of *Cayenne* or *cocculus indicus*, to give the adulterated article apparent strength; and, lastly, of unburnt and burnt *sugar*, to restore the sweetness and colour lost in consequence of dilution.

Results of the Examination of Samples.

Of *Twenty* samples of rum subjected to analysis, the *alcohol* ranged from 47 per cent. the highest, to 27 per cent. the lowest, while *Cayenne* was detected in six of the samples; that is, some of the spirits did not contain *half* as much alcohol as others, and consequently were not of *half* the value. The same, it will be remembered, was found to be the case with the gins examined; some of them contained only half the quantity of spirit that others did, and this although the price paid for them was nearly the same in all cases.

An instance leading to fatal results of the adulteration of rum with *cocculus indicus* occurred some time since at Liverpool. It is recorded in Dr. Taylor's book on "Toxicology."

Several sailors drank a glass each of the sophisticated spirit; one died the same evening, but the others, although made seriously ill, ultimately recovered.

Lead has been discovered in rum in some cases; this is generally to be regarded as an accidental impregnation, the lead being derived from the worm of the still. It is in *new* rum that lead is chiefly found. Dr. Traill found that the spirit received into a tumbler as it came from the still always contained lead, but that it disappeared from the same spirit after having been kept in an oaken cask for some time. The explanation of this curious fact is, that the spirit extracts tannin from the cask, and the lead uniting with this forms an insoluble compound and becomes precipitated.

There is a kind of rum termed "Pineapple Rum." This flavour of pineapple is communicated to the spirit by steeping in it slices of the pine. Recently chemists have found out methods of imitating very exactly the flavour of the pine, and hence this artificially prepared flavouring is often had recourse to in this country to convert not only ordinary rum, but even ordinary spirit into "Pineapple Rum."

This flavouring may be prepared by distilling butter with sulphuric acid and alcohol, or by combining amylic or potato ether with butyric acid, and then dissolving it in alcohol. This flavouring is much used in sweetmeats.

On the Detection of the Adulterations of Rum.

The methods to be employed for the detection of *water*, *sugar*, *Cayenne*, or *grains of paradise* and *lead*, are the same as those given for the discovery of the corresponding adulterations of gin. The process for the detection of *cocculus indicus* is described at p. 513; it is more easy to discover the presence of this poison in rum than in beer, owing to the smaller quantity of extractive matter contained in that spirit. A very excellent method of determining the presence of cocculus indicus is to evaporate about half a pint of rum to dryness, to dissolve the extract in about ten ounces or so of water, and to place in it a small live fish. If the spirit contain picrotoxin the fish will soon exhibit the usual symptoms of poisoning by that deadly substance.

The Customs' duty on rum is, in England and Scotland, 8*s.* 2*d.* per gall., hydrometer proof; in Ireland, 6*s.* 4*d.* per gallon.

The quantities taken for home consumption in the United Kingdom were, in 1854, 3,227,122 galls.; in 1855, 3,224,292 galls.; in nine months of 1856, 2,361,753 galls.

BRANDY, AND ITS ADULTERATIONS.

Brandy is the spirit obtained by the distillation of wine. When first distilled it is quite colourless, but, after having been kept for some time in an oaken cask, it becomes of a pale amber tint, the colour being derived from the wood of the cask. The very dark brandies owe their high colour, whereby their flavour is much injured, to *burnt sugar*. The characteristic taste and aroma of brandy is due to the presence of a volatile oil obtained from the grape.

The best brandies are those of France; they are but slightly rectified, and therefore are not strong, containing usually nearly half their weight of water. The reason of this is, that the re-distillation of the spirit injures the volatile oil, upon which the excellence of the brandy depends.

One of the most frequent adulterations of brandy is with *water*.

Another adulteration is with *spirit* obtained from *corn*, *sugar molasses*, *beet root*, or *potatoes*.

In some cases one or other of these different spirits are substituted for genuine brandy, the flavour of brandy being communicated to them by artificial flavourings, and the requisite colour being obtained by means of burnt sugar.

Much of even the French brandy imported into this country consists either in part or wholly of corn, and more frequently of beet root spirit.

Strange to relate, a very large quantity of corn spirit has of late been imported into France, to be used in the adulteration of French brandy. Part of this corn spirit is returned to us in the form of brandy, this adulterated brandy on its arrival in this country undergoing in many instances further adulteration by the addition of more corn spirit, and thus it becomes doubly adulterated.

The article known as "*British brandy*" consists for the most part of corn spirit flavoured. The flavouring is accomplished sometimes by the addition of a little genuine brandy, but more frequently by distillation of the murk, the name given to the refuse skins and pips of the grape left after the distillation of the wine. "The British brandy maker buys up this murk, and imports it into this country, paying upon it the same duty as upon wine. By distilling British molasses over these lees, the manufacturer obtains, to some extent, the peculiar flavour which characterises French brandy." *

Dr. Normandy, in reply to a question by Mr. Scholefield, makes these remarks in regard to the flavouring of brandy by means of artificially prepared essences: —"Brandy is extensively prepared in this country, especially since the discoveries of modern chemistry of producing essential oils artificially,—oils which have the odour of that particular ether to which brandy owes its flavour."

When molasses spirit is employed it is necessary it should be previously rectified by distillation over freshly burnt charcoal and quicklime. Indeed it is essential that all spirits, especially corn spirit, employed in the adulteration of brandy should undergo careful rectification, in order to free them from the peculiar tastes and odours which might but too plainly reveal the nature and origin of the spirit.

Receipts are of course not wanting for the manufacture of spurious French brandy. Dr. Ure gives the following formula, as one which is employed for converting corn spirit into imitation brandy. Pure alcohol is to be diluted to the proof strength, to every hundred weight of the spirit, half a pound of argol, wine stone, or cream of tartar previously dissolved in water, is added, as well as a little acetic ether, some French wine vinegar, bruised French plums, and flower stuff from Cognac (murk). The spirit is then to be distilled off, with a gentle fire, in an alembic furnished with an agitator. The spirit which comes over is coloured with burnt sugar to the tint required, and roughened to the taste with a few drops of the tincture of catechu or kino.

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* Tricks of Trade, p. 110.

Oak sawdust and tincture of grape stones, prepared purposely from the murk, are used to impart to new brandy the taste of an old spirit which has become ripened in an oaken cask.

The author of a work on "Malted and Unmalted Corn, connected with Brewing and Distilling" gives the following receipt for making an adulterated brandy, suitable for retail purposes:—

To 10 puncheons of brandy - -	1081	gallons
Add flavouring raisin spirit - -	118	„
Tincture of grains of paradise - -	4	„
Cherry laurel water - - - -	2	„
Spirit of almond cake - - - -	2	„
	1207	gallons.

Add also 10 handfuls of oak sawdust, and give it complexion with burnt sugar.

The case of brandy affords, then, an apt illustration of the pitch of refinement to which the art of adulteration has reached in these days.

Results of the Examination of Samples.

Of *Eighteen* samples of brandy subjected to examination —

The *alcohol* ranged from 30 to 50 per cent.

The majority of the samples consisted of so-called *British brandy.*

Nearly all the brandies were coloured with *burnt sugar.*

Lastly, in none of the samples was *Cayenne* present. This is particularly worthy of note, because some of the brandies were procured at houses at which both the gin and the rum were found to be adulterated with that substance. This at least shows that acrid substances are not so frequently employed in the adulteration of brandy as of other spirituous liquors. This result is, therefore, in some degree satisfactory.

Brandy and rum are seizable if sold by or found in the possession of the dealer unless it possesses a certain strength, 17 per cent. below proof, by Sykes' hydrometer. The following are the words of the Act, 30th Geo. III.:—

"No distiller, rectifier, compounder, or dealer shall serve or send out any foreign spirits of a lower strength than that of one in six under hydrometer proof, nor have in his possession any foreign spirits mixed together except shrub, cherry or raspberry brandy, of lower strength than as aforesaid, upon pain of such spirits being forfeited; and such spirits, with the casks and vessels containing the same, may be seized by any officer of Excise."

It will be perceived that many of the brandies examined by us were sold in violation of the act above quoted, and, as usual, without let or hindrance by the Excise.

On the Detection of the Adulterations of Brandy.

The methods already pointed out under the heads of Gin and Rum, are equally applicable to the discovery of the adulterations of brandy; the strength of the brandy must be ascertained, the kind of spirit if possible, the amount and nature of the extractive, and the sulphates present must likewise be determined.

We will now inquire as to the capabilities of the Excise to detect adulterations in spirits; and first the reader may be reminded that adulteration has been found to be rife in gin, rum, and brandy. As in so many other cases, we need only refer to the evidence of Mr. George Phillips to be made acquainted with the state of the case as respects the Excise.

Mr. Villiers. "We have had evidence here to the effect that a mixture or adulteration is invariable in all public houses: what is the course adopted with a view to detecting those practices?"—"The fact is, we have abandoned what is termed stock taking of the retailers. The trade is thrown open, and they are left to do pretty much as they like. At the present moment, so far as stock taking is concerned, we have power to take their stock if we think proper; the goods are sent in with a permit, and the trader enters them in a book, and when the officer goes he takes up this document representing the receipt of a certain spirit, and if we think proper we can take the stock."

"Is not the revenue defrauded in this way?"—"I think not. If the public wished to drink gin at 50 per cent. under proof, the retailer could have it sent to him. *The law prohibits him from putting anything to it himself. He is not allowed to add sugar or water to his gin; it is an act of compounding which we do not recognise.*"

"The duty is not paid on gin and water?"—"No; it is paid on the spirit. Suppose, for instance, the publican buys his gin at 17 under proof. That may be too strong for ordinary taste, and therefore the publican, when he gets it in at that strength, reduces it probably. *I cannot say that he does so from actual knowledge*, but we may suppose that he does."

It is notorious that the publican almost constantly reduces his gin with water, adds sugar, and often Cayenne and other ingredients. As has been stated by Mr. Phillips, the law prohibits this act of compounding, and has charged the Excise with the duty of ascertaining whether the prohibition is observed or not; but the Excise leaves the publicans "to do pretty much as they like," and consequently they are unable to speak to facts in regard to the adulteration of gin which are notorious to the public at large. But let us observe what further information Mr. Phillips affords the Committee respecting the adulteration of spirits.

Chairman. "Have you heard of Cayenne pepper being mixed with *gin?*"—"I have *heard* so; it could be detected, of course."

Mr. Villiers. "Have you never had any experience of the adulteration of spirits during the twelve years you have spoken of?"— "*I do not recollect a case.*"

"Is brandy ever adulterated?"—"If you view colouring matter as adulteration it is always adulterated."

"Do you know if it is ever reduced with water and then made stronger by the introduction of other ingredients?"—"I cannot speak to the use of other ingredients. I have no knowledge of what a particular trader may do."

"The evidence which has been given before the Committee, therefore, has not reached the Excise yet?"—"I have not seen it."

These replies certainly evince an amount of ignorance of the adulteration which actually occurs in the articles enumerated, which, considering the position and duties of the Excise, is really astounding.

Customs' duty on brandy, 15*s.* per gall., hydrometer proof.

Taken for home consumption in 1854, 1,863,622 galls.; in 1855, 1,526,221 galls.; in nine months of 1856, 1,109,497 galls.

The quantity in 1853 was 2,378,981 galls. The diminution is owing to the cost, ex-duty, having been more than doubled.

WINE, AND ITS ADULTERATIONS.

Wine is the fermented juice of the grape; it is distinguished from other fermented and alcoholic liquids by containing bitartrate of potash, or cream of tartar, commonly called winestone, a constituent of the grape.

The numerous varieties of wine are occasioned by differences of soil, climate, season, and by the kind, quality, and condition of the grape as to ripeness, the mode of fermentation, the manner and temperature at which the wine is preserved, and by its age.

All wines possess a characteristic taste and aroma or *bouquet*, as it is termed. These varieties depend upon differences in the volatile and aromatic principles, mostly of an oily nature, generated during fermentation and distillation. Contrary to what might have been anticipated, the wines of warm countries possess but little bouquet; those of the "central departments of France have it in a marked degree, whilst the wines of the still more northerly situated Germany have the most intense perfume. The grapes which are gathered before they are completely ripe have the strongest bouquet."*

The *vinous odour* of wine is produced by the presence of a volatile substance, which has received the name of *œnanthic* ether; it possesses a sharp, disagreeable taste, but the odour of wine in its most powerful degree; it is produced during fermentation, and seems to increase in quantity in wine by keeping, as the odour of old is stronger than that of new wines.

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* Tricks of Trade, p. 126.

The different wines may be classified under one or other of the following heads:—*Strong* and *light*, *sweet* and *dry*, *sparkling* and *still*, *white* and *red*.

The *strong* wines, such as sherry, port, Madeira, &c., are made from thoroughly ripened grapes, grown in southern countries, and which, from containing more sugar, yield, when fermented, a greater amount of alcohol, the ingredient which gives to wine its strength.

The amount of *absolute alcohol* usually present in wines commonly in use, is as follows:—

In 100 Measures.

Johnston.

Port	21 to 23
Sherry	15 to 25
Madeira	18 to 22
Marsala	14 to 21
Claret	9 to 15
Burgundy	7 to 13
Rhenish	8 to 13
Moselle	8 to 9
Malmsey	16
Tokay	9
Champagne	5 to 15

Brande.

Marsala	25
Port	23
Madeira	22
Cape	20
Sherry	19
Montellado	12
Constantia	18 to 20
Malaga	18
Bucellas	18
Hermitage (White)	17
„ (Red)	12
Claret	15
Malmsey	16
Santerne	15
Burgundy	14
Tent	13
Hock	12
Champagne	12
Vin de Grave	13
Côte Rôtie	12
Tokay	10

From Liebig's Letters. Arranged according to Price.

		Alcohol per Cent.	Residue.	
Steinberger,	1846	10·17	10·55	Fresenius.
Marcobrunner,	„	11·14	5·18	
Hattenheimer,	„	10·71	4·21	
Steinberger,	1822	10·87	9·94	
Rudesheimer,	„	12·61	5·39	
Marcobrunner,	„	11·60	5·10	
Geisenbrunner,	„	12·60	3·06	

The per-centages of alcohol in the wines in use in this country Dr. Jones found to be as follow:—

	Alcohol by Measure.
Port - - -	from 20·7 to 23·2 per cent.
Sherry - -	15·4 to 24·7 „
Madeira - -	19·0 to 19·7 „
Marsala - -	19·9 to 21·1 „
Claret - -	9·1 to 11·1 „
Burgundy - -	10·1 to 13·2 „
Rhine Wine -	9·5 to 13·0 „
Moselle - -	8·7 to 9·4 „
Champagne -	14·1 to 14·8 „

These results, which are rather high, were obtained by means of the alcoholometer of M. Geisler.

Some idea of the relative strength of wine may be formed when it is mentioned that good brandy and rum usually contain from 45 to 50 per cent. of absolute alcohol, poor beer about 2 per cent., porter rather over 3, and stout about 5 or 6 per cent. We thus perceive that Marsala, port, and Madeira contain about half as much alcohol as brandy.

The amount of alcohol in wines is materially affected by their *age*, it being in most wines reduced in quantity by keeping, part of it being lost by the evaporation which takes place even in tightly corked bottles, and part by the oxidation of the alcohol, and its conversion into acetic acid.

To this rule, however, Madeira and sherry form exceptions, since these rather increase in strength for the first five or six years, owing to the conversion of the sugar which they contain into alcohol.

In connection with the strength of wine its *acidity* may be considered, since in some, though not in all cases, the acidity in part is dependent upon the strength. While the acidity of beer is occasioned mainly by acetic acid, and that of cider by lactic acid, that of wine is produced by tartaric acid. In the last two liquors, however, acetic acid also is present in greater or less proportion; it is always formed at the expense of the alcohol when the fermentation proceeds too far.

Wines made from unripe grapes sometimes contain citric acid; as the fruit ripens, this acid is replaced by the tartaric.

Tartaric acid exists in the juice of the grape and in wine in combination with potash, forming what is called bitartrate of potash or cream of tartar, the sour taste of which is well known. When wine is left at rest this salt is in part precipitated, and the wine becomes so much the less acid. This is one of the good effects of age upon wine.

The following is the order of *acidity* of some of the chief wines consumed in this country:—

Sherry is the *least acid.*
Port comes next.
Champagne.
Claret.
Madeira.
Burgundy.
Rhine Wines.
Moselle is the *most acid.*

The principal *sweet* wines are Tokay, tent, Frontignac, and Malmsey; they are made from grapes so ripe that they are almost shrivelled up to raisins, and which therefore contain much sugar, the fermentation also being arrested before all the sugar is converted into alcohol.

The order of sweetness of certain wines, or the amount of *sugar* present, was ascertained by Dr. Bence Jones to be as follows:—

Claret, Burgundy, Rhine, and Moselle wines, including hock, contain no sensible quantity of sugar.

Sherry contains -	4 to 18	grains	of sugar in	the ounce.
Madeira - - -	6 to 20	„	„	„
Champagne - -	6 to 28	„	„	„
Port - - -	16 to 34	„	„	„
Malmsey - - -	56 to 66	„	„	„
Tokay - - -	74	„	„	„
Samos - - -	88	„	„	„
Pascarette - -	94	„	„	„

The sugar was estimated by the saccharometer of M. Soleil.

In the *dry* wines, as in some kinds of sherry, especially Amontillado, the fermentation is prolonged until nearly all the sugar has disappeared.

In *effervescing* or *sparkling* wines the wine is put into casks or bottles while the fermentation is still progressing: the consequence of this is that much carbonic acid accumulates in the wine, causing it to effervesce when uncorked.

Both *white* and *red* wines may be made from the coloured or red grape. The colouring matter is situated in the husk. The white wines are prepared from the juice of the grape only, while for the red wines the whole grape is used.

On the Adulterations of Wine.

The wines, of the adulteration of which we propose to treat, are port, sherry, Madeira, Champagne, claret, hock, and Moselle.

There are no manufactured articles subject to greater adulteration than wines, and this on account of the high price they bear, the extent to which they are consumed, and the ease with which many of them may be imitated, and this in a variety of ways which altogether baffle the efforts of science to detect.

Although many adulterations are practised upon wine which cannot be and never are discovered, yet much evidence has been obtained of the general prevalence of adulteration in wine, and science has also supplied means for the detection of many of the sophistications practised.

PORT, AND ITS ADULTERATIONS.

Of all wines none is subject to more adulteration than port wine.

• The first adulteration often practised upon it consists in adding *brandy*, sometimes to the extent of twelve gallons to the pipe, even while fermentation is going on. This practice is said to be most injurious to the flavour of the wine.

Another practice is to increase the colour of the wine by artificial means: this is usually effected by *elder berry colouring*, more brandy being added with the colouring. So common is this practice, that elder berry trees are grown in many of the vineyards, while other proprietors, it is asserted, have been known to pay as much as 400*l.* per annum for the elder berries used by them.

Before the wine is shipped more brandy is added, and also sometimes a mixture denominated *Jèrupiga.* This is a compound expressly prepared for the adulteration of port wine; it consists of *the juice of elder berries*, *brown sugar*, *unfermented grape juice*, and *brandy.*

Further, this article is extensively imported into this country for the adulteration of port wine. By a return recently made to the House of Commons on the motion of Mr. Oliveira, M.P., it appears that jerupiga was imported and used by some of the first houses engaged in the wine trade in this country.

Another substance used to colour port wine, both in Portugal and at home, is *logwood;* large quantities of this dye are, it is stated, imported into Oporto.

Lastly, port wines are adulterated at Oporto *by the addition of inferior wines*, imported for the purpose. It is by this means that the supply of port wine is maintained at a tolerably uniform average, no matter what may have been the vintage.

It is therefore evident that port wine is subject to a large amount of adulteration, even before it reaches this country; after its arrival here it is frequently subjected to further adulteration.

Sometimes it is diluted, brandied, and then coloured by the mixture termed jerupiga, or by means of logwood. The brilliancy of its colour is sometimes increased by means of *alum*, and if turbid, it is cleared by *gypsum*, while increased astringency is sometimes imparted by means of *oak sawdust.* Not unfrequently peculiar flavours or bouquets are artificially communicated to port wine: the principal substances used for this purpose are *extract of sweet briar*, *orris root*, *cherry laurel water*, &c.

In other cases the true flavour and taste are given to factitious port by means of *a tincture made from the seeds of the grape.*

The resemblance to port is further increased by adding *salt of tartar* to the wine, which, it will be remembered, is one of the natural constituents of the grape. This salt after a time becomes in part deposited in a crystalline state from genuine port wine, either on the sides of the cask, or even in the bottle in which it is kept, it carrying down with it some of the colouring matter of the wine. The fabricators of spurious port have not forgotten to imitate this criterion of a good wine.

For this purpose a hot saturated solution of cream of tartar, coloured red with a decoction of Brazil wood, is placed in the cask and rolled about in it until the sides become covered with the crystallised substance, after which the imitation wine is poured in. Bottles even are treated in the same manner, and the very corks are also dyed. The crust of port wine is an indication of its age, and not only is this produced in the manner just pointed out, but likewise in other ways; one of these is to put new port into warm water, the temperature of this is raised to the boiling point, after which the wine is put back into the cellar, when it soon deposits a crust which might pass for the growth of years.

But wine not unfrequently contains *lead:* in some cases this is an accidental impurity or impregnation, but more frequently it is to be regarded as an adulteration.

When lead is accidentally present it is derived from the shot used in cleaning the bottles.

When added intentionally to wine, it is so for the purpose of preventing it from turning sour.

Dr. Watson[*] states that the practice of adding lead to wine was at one time common in Paris.

Dr. Warren[†] relates an instance in which thirty-two persons were made seriously ill by drinking wine adulterated with lead; one of them died, and another became paralytic.

In Dr. Ure's "Dictionary,"[‡] we find these remarks in relation to the use of lead in France: — "This distemper (excessive acidity) formerly gave rise to the very dangerous practice of adding litharge as a sweetener, whereby a quantity of acetate or sugar of lead was formed in the liquor, productive of the most deleterious consequences to those who drank of it. In France the regulations of the police and the enlightened surveillance of the Council of Salubrity have completely put down this gross abuse."

Lastly, Graham in his "Treatise on Wine Making," published many years since, under the article "Secrets," belonging to the mysteries of vintners, recommends lead to be used for several purposes. The following receipts are copied from that mischievous work: —

"*To hinder Wine from turning.*

"Put a pound of lead melted in water into your cask pretty warm, and stop it close."

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[*] Chemical Essays, vol. viii. p. 369.

[†] Medical Trans. vol. ii. p. 80.

[‡] Vol. ii. p. 1303.

" *To soften Grey Wine.*

" Put in a little vinegar wherein litharge has been well steeped, and boil some honey to draw out the wax. Strain it through a cloth, and put a quart of it into a tierce (42 gallons) of wine, and *this will mend it.*"

To cure Wine of its Muddiness.

A lump of sugar of lead of the size of a walnut and a tablespoonful of sal enixum are directed to be added to a tierce of wine.

Accum has the following remarks in reference to the use of lead in wine:—

" The most dangerous adulteration of wine is by some preparations of lead that possess the property of stopping the progress of acescence in wine, and also of rendering white wines, when muddy, transparent. I have good reason to state that lead is certainly employed for this purpose."

" Lead, in whatever state it is taken into the stomach, occasions terrible diseases, and wine adulterated with the minutest quantity of it becomes a slow poison. The merchant or dealer who practises this dangerous sophistication adds the crime of murder to that of fraud, and deliberately scatters the seeds of disease and death amongst those consumers who contribute to his emolument. If to deface the current coin of the realm be denounced as a capital offence, what punishment should be awarded against a practice which converts into poison a liquor used for sacred purposes!" These remarks have a wider application than to the subject of the adulteration of wine with lead.

It must be remembered that lead may be present in other wines as well as in port.

It appears that no real necessity ever exists for having recourse to lead to remedy the more usual defects of wine.

It may here be stated that the muddiness, and especially the ropiness and viscidity of wine is due to the presence of an azotised matter precipitable by means of tannin. It is in white wines deficient in tannin that this malady chiefly occurs. M. François recommends for its cure the use of the bruised berries of the mountain ash in a somewhat unripe state, and of which one pound well stirred in is sufficient for a barrel.

But we have not yet exhausted the list of adulterations practised upon that much abused wine, port.

Accum states, "many thousand pipes of spoiled cider are annually brought hither from the country for the purpose of being converted into factitious port wine."

The business of imitating wines is in many continental towns a distinct and acknowledged occupation. The author of the " Tricks of Trade" has the following remarks on this subject:—

" At Cette, in France, those following this trade do not hesitate to fasten boards with 'Wines manufactured here' over their doors. Large shipments of spurious port arrive from this town, most of which do not contain one drop of the real wine."

Another method practised of adulterating port wine is to mix together a variety of cheap red wines, adding a little genuine port. This system is exposed in a work entitled "Wine and Spirit Adulterations Unmasked." The author states that large vats are kept by the manufacturer in which different inferior wines are mixed together in imitation of port. These are for the most part Beni Carlos, Figuras, and Red Cape. Beni Carlos may be purchased, duty included, at 38*l.* per pipe, Figuras at 45*l.*, and Red Cape at 32*l.* One or more of these are mixed together, a proportion of common port added, and a small quantity of mountain, to impart a softness and give a rich appearance. Salt of tartar will ensure a quick and firm crust, and gum dragon give a fulness of flavour, a consistency of body, and a good face. Berry dye, a colouring matter imported from Germany for the express purpose of adulteration, will increase the deep purple tint, while with washings of brandy casks the whole compound is made perfect. Wine thus made up would cost only about 16*s.* 9*d.* per dozen, every expense included.

Various receipts have been published for the manufacture of spurious port. The following are from the "Publican's Guide:"—"The cask is to be well sulphured, and then twelve gallons of strong port, three gallons of Cognac brandy, six of proof spirits of wine, and forty-two of good rough cider, making in all a compound at the rate of 18*s.* per dozen." A second receipt is as follows:—"Take forty-five gallons of cider, six of brandy, two of a decoction of sloes, and eight of port wine. To increase the colour, tincture of red sanders wood or cudbear must be added. The wine is to be bottled in a few days, and a teaspoonful of powdered catechu added to each bottle to give a rough and astringent flavour and to ensure a fine crust; lastly, in order to give an appearance of age, the ends of the corks are to be stained by soaking them in a strong decoction of Brazil wood containing a little alum."

Dr. Reece's "Gazette of Health" contains the following receipt:—"Take of British grape wine or cider four gallons, of the juice of red beet two quarts, of brandy two quarts, of logwood four ounces, or rhatany root bruised half a pound. First infuse the logwood and rhatany root in brandy and a gallon of grape wine or cider for a week. Then strain the liquor, and mix it well with the ingredients; keep it in a cask for a month, when it will be fit to bottle.

The following receipt for the manufacture of "*Southampton Port*" is from the same work:—"Take cider thirty-six gallons, elder wine eleven gallons, brandy five gallons, damson wine eleven gallons, and mix."

It thus appears that great and scandalous tricks are played with the English gentleman's favourite after-dinner beverage.

The consumption of port wine has recently much declined, doubtless in consequence of the knowledge of its adulteration being more extensively diffused. It is to be hoped that this result will lead to a reaction, and teach the adulterators that they are perilling the consumption of this wine in this the great port wine drinking country.

SHERRY, AND ITS ADULTERATIONS.

The grapes from which this wine is made are white; they are grown in the province of Andalusia, near Cadiz, in Spain: those which furnish the better qualities of wine are cultivated in the vineyards surrounding the town of Xeres de la Frontera, and hence the wine is called the wine of Xeres. The vineyards from which the British market is supplied extend over 80,000 acres of land: they furnish nearly half a million pipes of wine, of which the greater quantity, to the value of 450,000*l*., is exported abroad.

The greatest care and labour are bestowed upon the cultivation of the vines from the fruit of which sherry is made.

The grapes are not gathered until they are very ripe, and even somewhat shrivelled with the heat of the sun; sometimes the fruit after being plucked is exposed to the sun for a day or two, and for the very best wine the finest grapes only are used.

The fermentation is continued until nearly all the sugar has become converted, and the wine is often not drawn off for four or five months after the commencement of fermentation. It is at first of a pale straw colour, but darkens with age. Sometimes, however, a peculiar colouring liquid, termed "arrope," is added. This is prepared by boiling sherry down to a syrup. It is by the addition of this substance that the dark sherries are prepared.

The sherry termed *Amontillado*, and which at the present time is so much in favour with us, is a very dry wine. A singular fact with regard to this wine is, that its peculiarities are not due to any ascertained causes capable of imitation, but are entirely accidental so far as the manufacture is concerned. In attempting to prepare it the fruit is plucked at a much earlier period, and trodden down by the peasants; but of a hundred butts of wine made from the same grapes and by the same process, some only will be Amontillado and some ordinary sherry.

Sherry bears too high a price and is too extensively consumed to escape the hands of adulterators. It is never adulterated by the growers, but either by the importer or by the merchant at home.

Previous to its exportation, a proportion of *brandy* is nearly always added to sherry. This is a very unnecessary and injurious practice, since it cannot fail to injure the delicacy of the flavour of the wine, and to retard those natural changes in it consequent upon keeping, and which are so improving to its quality.

The chief adulterations of sherry consist either in mixing with genuine sherry of the first quality inferior sherries, in adding to sherry *other wines* of inferior quality not sherry at all, or sometimes *factitious compounds*, not containing any grape juice, are substituted for sherry.

Low priced sherries are imported from Spain at about 18*l.* per butt, expressly for adulteration. On their arrival they are mixed with cape and cheap brandy, and the mixture is flavoured in imitation of good sherry, the colour being either increased or diminished according as brown or pale sherry is required.

The author of the "Tricks of Trade" states that at Cette, in France, great quantities of sherries are made up and shipped for the English market, the composition of which is nothing more than *a cheap white wine*, strengthened with *brandy*, coloured with *treacle*, and flavoured with *almonds*.

Lastly, the same writer states, a kind of sherry is manufactured in this country, the basis of which is *pale malt* and *sugar candy*, a small quantity of French *brandy* and *inferior wine* being added to flavour the mixture.

The practice of restoring muddy or ropy wines by means of lead is also resorted to in the case of sherry and most of the other wines

Genuine sherry is a very wholesome wine, in consequence of its freedom from acidity, sugar, and other extractive matters.

MADEIRA, AND ITS ADULTERATIONS.

The different qualities of Madeira are distinguished as south and north wines, according to the side of the island on which the trees were grown from which the wine is made, the former being three times more valuable than the latter.

In the manufacture of the better qualities of Madeira, the juice is expressed by trampling on the grapes; this is drawn off, and a further quantity of juice obtained by the action of the press on the murk, and from this an inferior quality of wine is prepared. The fermentation is usually continued for about six weeks, the juice being constantly agitated.

For the ripening or mellowing of the wine, heat and motion are had recourse to.

One plan is to keep the wines in stores heated to about 90° F.

Another is to place the bottles, well corked, in heaps of fermenting manure.

Lastly, in some cases Madeira is sent one or more voyages to the

East Indies, the heat of the climate and the constant agitation in which the wine is kept very greatly improving its qualities.

The adulterations to which Madeira is subject are in the main similar to those of sherry and other white wines. Madeira of inferior quality is mixed with and passed off for the best, and wines are fabricated in imitation of Madeira, but really not containing a drop of that wine in them. A spurious Madeira is sometimes made from a Canary wine called *Vedonia,* which somewhat resembles Madeira, and, like it, is improved by heat and agitation. This is mixed with a small quantity of *mountain port* and *cape*, "sweetened with *sugar candy*, flavoured with *bitter almonds*," and then subjected to a hot water process to give it mellowness and age.

Of course, a higher price is charged for Madeira which has been to the East Indies. Much that is sold as having undergone the voyage has never been to the East at all. It is stated that, in order to aid this deception, casks are branded and false bills of freight exhibited.

Many imagine that wines purchased at the docks *must* be pure: there is good reason for believing that this is not always so. On this subject, we find in the "Tricks of Trade," the article in which work on wine is full of interesting information, the following remarks:—"The crafty importer, in general, orders his ships, on their way to England, to touch at Guernsey or Jersey, when the required adulterations are practised."

Some idea of the extent to which Madeira is adulterated may be formed, when it is known that not more than 25,000 pipes are made; of these not more than 3,000 belong to the first growth, of which only about one half reaches this country.

CLARET, AND ITS ADULTERATIONS.

St. Estiphe, St. Julien, Pouillac, and La Rose are all light, agreeable, and aromatic wines, exhilarating gently, without after depression.

The celebrated Château Margaux is a fine wine, having the perfume of the violet, and a rich ruby colour.

Haut Brun is valued for its peculiar flavour and its powerful bouquet, which resembles a mixture of violets and raspberries.

The much esteemed wines, Latour and Lafitte, the former being the stronger wine, possess a fine violet perfume and taste, their colour also being dark violet.

The greater part of the claret sold in this country consists of nothing more than the cheap red wines of France used by the peasants, and sold at most of the ordinary wine shops.

"Occasionally a cheap common French wine is mixed with rough *cider*, and coloured to the appearance of claret with *cochineal*, *logwood*, and other materials."*

Burgundy may be classed amongst the claret wines: it is perhaps the finest of all the red wines; it is stronger than ordinary clarets, the strength being sometimes increased by the addition of brandy. It possesses a powerful aroma, and a delicious and lasting flavour; it is slightly astringent, and hence sometimes occasions headache and indigestion. It must be remembered, however, that as it arrives in this country it is usually brandied, and this may in some instances account for the effects produced.

The addition of *brandy* to Burgundy is most injurious to its flavour and smell. So delicate is this wine that it is said that if two Burgundies of superior qualities are mixed together, the bouquet and taste are entirely changed.

CHAMPAGNE, AND ITS ADULTERATIONS.

The grape from which Champagne is made is black. The process of manufacture is most carefully conducted. The grapes are first examined, every bruised or unripe grape being removed. For the grey or white Champagne, the grapes are trodden for a quarter of an hour before being pressed. For the pink wine, the treading is prolonged until the juice becomes tinged with the colouring matter of the husks. For inferior Champagne, the colour is sometimes artificially produced by means of a little *red wine*, or even by the juice of *elder berries*.

The white Champagnes are therefore in general to be regarded as purer than the pink varieties.

Champagnes are not only classified according to their colours, but also into still and sparkling. The best of the still wines is Sillery, a dry Champagne, of an amber colour, rich body, and powerful bouquet.

Of the Champagne sold in England a very large proportion is spurious.

Sometimes it is fabricated from cheap *white French wine*, *sugar*, and *colouring matter* being added.

At others it consists in part, or even wholly, of wine made from the *gooseberry*.

Not unfrequently it is manufactured after the following, or some similar receipt:—"Take of white sugar eight pounds, the whitest brown sugar seven pounds, crystalline lemon acid or tartaric acid a quarter of an ounce, pure water eight gallons, white grape wine two quarts, or perry four quarts, of French brandy three pints. Boil the sugar in the water, skimming it occasionally, for two hours; then pour it into a tub, and dissolve in it the acid before it is cold. Add yeast, and ferment. Put it into a clean cask, and add the other ingredients. The cask is to be well bunged, and kept in a cool place for two or three months; then bottle, and keep it cool for a month longer, when it will be fit for use. By adding one pound of fresh or preserved strawberries, and two ounces of powdered cochineal, the pink Champagne may be made."

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* Tricks of Trade.

The Champagne sold at races, fairs, and tea gardens is rarely ever genuine.

GERMAN WINES, AND THEIR ADULTERATIONS.

The vine generally cultivated on the banks of the Rhine, and its tributaries the Moselle and the Mayne, is called the Ressling. The grapes which it bears are small and possess a harsh taste, but the wines made from them are remarkable for their aroma and pleasant flavour.

The chief German wines are *Johannisberger*, *Steinberger*, *Rudesheimer* a red wine, *Hockheimer* or *Hock*, and *Moselle*.

Johannisberger is grown in the courtyard of the castle of Johannisberg, on the banks of the Rhine, and the quantity of this wine made is so small that it is for the most part disposed of privately, and can rarely be obtained for either love or money. Wine may be purchased in Germany freely enough, but at a high price, under the name of Johannisberger, but this is rarely if ever what it is represented.

Steinberger is said almost to rival Johannisberger. The vineyard from the grapes of which this wine is made contains only 108 acres, so that the supply of this wine is also extremely limited.

The vines from which *Hockheimer* or Hock is produced grow round the town of Hockheim, near to Mayence and Frankfort, on the banks of the Mayne.

Rudesheimer is another much esteemed wine, a small quantity of it only being made, and which is soon all bought up on the spot.

The most celebrated *Moselle* wines are those named *Scharzberger* and *Grunhauser*, also called the "Nectar of the Moselle."

Not very much is known respecting the adulteration of the German wines; they are probably confined principally to hock and Moselle.

"Cheap light French wines are perfumed with essences, placed in bottles of the colour and shape peculiar to the Rhenish wines, and often passed off at enormous prices as the choicest specimens of the German vineyards. In England the demand for them is small, so that as yet it has not been worthy the attention of the trade to adulterate largely; for as the consumers are few and far between, and these sophistications spoil with keeping, the loss would be larger than the profits gained by the deceit." *

On the Detection of the Adulterations of Wine.

It is unfortunate that many of the adulterations practised upon wine do not, in the present state of organic chemistry, admit of being discovered. This remark applies especially to those adulterations which consist in the mixture of different kinds of wine, and to the various vegetable substances employed. Nevertheless many of the adulterations of wine, including some of those which are injurious to health, do admit of detection, and we shall now describe the methods by which these may be discovered.

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* Tricks of Trade.

The *strength of wine* depends upon the amount of alcohol contained in it; this may be in excess from the wine containing *brandy*, or it may be deficient from its dilution with *water*. It is therefore frequently necessary to ascertain the quantity of alcohol present. The methods by which this determination is effected in the case of wine, are nearly the same as in spirits and other alcoholic liquids. They will be found described in the article on Gin.

When the wine contains little or no extractive matter, its weight may be taken at once with the specific gravity bottle, and the alcohol calculated direct from it. When, however, much sugar or other extractive is present, then the spirit must be separated by distillation, or the following more ready method may be adopted:—

To eight parts by measure of the wine, add one part of a concentrated solution of subacetate of lead; a precipitate will ensue consisting of the extractive matters, the gum, colouring, albuminous, and acid matters of the wine in combination with part of the lead; separate the precipitate by filtration, add to the filtered liquid, in small quantities at a time, pure and recently ignited subcarbonate of potash until the last portion added ceases to be dissolved. The potash abstracts the water from the spirit, which floats on the surface, forming a distinct stratum. If the liquid, previous to the addition of the potash, be poured into a glass tube graduated in per-centages, and the potash be subsequently added, the quantity or per-centage of spirit may be ascertained by mere inspection of the scale.

If the spirit be separated by distillation, the smell of the distillate, especially when warm, will frequently betray the presence of volatile substances—as *cherry laurel water*, and in some cases *corn spirit.* The characteristic odour of this spirit is brought out especially by rubbing some of the strong spirit briskly between the palms of the hands, and then smelling it.

On the Determination of the Extractive.—For this purpose a measured quantity of wine should be evaporated on a water-bath, until it ceases to lose weight. The presence of a variety of foreign substances may frequently be detected in this extractive by the smell and taste, especially the smell emitted by the wine while hot, and as the evaporation draws to a close. In this manner, the odour of *elder berries*, of *cider*, *gooseberries*, and other fragrant and aromatic substances may frequently be detected; and by the taste the presence of *catechu* and *Cayenne* determined. The taste of the *apple* or *pear* becomes, according to Normandy, more evident after the removal of the bitartrate of potash.

On the Determination of the Sugar.—The amount of sugar present in wine may be ascertained in either of the following ways:—The extractive is to be thrown down by means of subacetate of lead, the wine filtered, the excess of lead removed by sulphuretted hydrogen passed into it through water, as in a Woolfe's apparatus, the wine again filtered, and then evaporated to dryness. The residue consists of nearly pure sugar. Or we may employ the copper test, as described under the head of Sugar.*

On the Determination of the Acidity.—The process is detailed under the head of Beer.

On the Determination of the Bitartrate of Potash.—This salt is also called cream of tartar and wine stone. 5000 grains by measure of the wine are to be evaporated to dryness, and the residue ignited; by the ignition the acid bitartrate is converted into the alkaline carbonate, the amount of alkali is then determined by means of a solution of ascertained strength of dilute sulphuric acid. If an alkali, as the carbonates of soda, potash, or lime, has been added for the purpose of correcting the undue acidity of the wine, this method is fallacious; and we must then crystallise the tartrate of potash from a concentrated watery solution.

The solution may be thus prepared:—The wine is to be evaporated to a syrupy consistence, and allowed to cool without stirring for twenty-four hours; at the end of that time the clear liquid should be decanted from any crystals of cream of tartar which may have formed; the decanted liquid is to be diluted with distilled water, and evaporated as before. The crystals, if any have formed, are again separated by decantation, and the operation repeated until no more crystals are formed.

Another way is to calculate the bitartrate from the quantity of chloride of potassium obtained, and if carbonate of soda also has been added, to estimate this from the chloride of sodium found. The processes for the quantitative determination of the chlorides of potassium and sodium are given under the heads of Turmeric and Annatto.

On the Determination of the Presence of Foreign Colouring Matters.—Some of these, especially the colouring matter of the *elder berry*, may often be determined, as already noticed, by the odour of the warm or hot extract of the wine. Certain chemical methods have, however, been described for effecting the discrimination in question.

Method of M. Vogel.—This chemist has recommended acetate of lead for the detection of extraneous colouring matters in red wine. With this reagent he states that genuine red wine gives a greenish grey precipitate, but that in the case of wine coloured with the juice of *bilberries*, *elder berries*, or *Campeachy wood*, the precipitate is deep blue, while with *Brazil wood*, *red sanders*, and *beet*, it is red. Wine coloured by beet root is also rendered colourless by lime water, but the weakest acid brings back the colour.

Mitchell states that the precipitate with acetate of lead from an infusion of *logwood* is purple red, and that if the colouring matter be very much diluted it has a leaden or bluish hue. With the juice of beet the colour is puce; when diluted with water the tint becomes a pale salmon red.

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* Wine being sometimes adulterated with *cane sugar*, it is occasionally necessary to discriminate between grape and cane sugars: the method will be found described under the article *Honey*.

According to Berzelius, the colouring matters of red wine give different coloured precipitates with diacetate of lead, according to the age of the wine, and that in new red wine the precipitate is generally blue. If this is correct, the value of the test of M. Voyel is of course much diminished.

This statement seems opposed, however, to the following experiment of M. Voyel. It has already been stated that the colour of the red wines is derived from the colouring matter located in the skin of the grapes. In order further to assure himself, he prepared a quantity of grape skins, reduced them to powder, and treated them with alcohol. This took up part of the colouring matter, and when acetate of lead was added, the same greyish green precipitate was obtained. Lastly, it should be stated that the wines principally experimented upon by M. Voyel were new wines, and were made by himself from black grapes for the purpose of his experiments.

Method of M. Chevallier.—Solution of caustic potash, added to genuine red wine in such quantity as to neutralise all the acid, causes the colour to change from red to bottle green, and after some time to brownish green, but no precipitate is formed. The colours produced when foreign colouring matters have been employed are different, as shown in the following table:—

Wine coloured with—	Colour produced by potash—
Elderberries	Purple.
Logwood	Reddish purple.
Red mulberries	Purplish.
Brazil wood	Red.
Beet root juice	Red.
Litmus	Light violet.

Method of M. Jacob.—The colouring matters experimented upon were those of the petals of the poppy, of logwood, and of Brazil wood. The reagents which he employed were sulphate of alumina and carbonate of ammonia.

Normal wine furnished a slightly coloured *greyish* precipitate. The same wines, with *Brazil wood*, give a *carmine red* precipitate which varied in intensity with the quantity of colouring matter added; with *logwood* the precipitate was of a fine *deep violet colour*, and with *red poppy* of a *slate-grey* colour.

The reagents were thus employed:—A solution of sulphate of alumina was made, containing 10 parts of the salt to 100 of water; about half a drachm of this solution was added to an equal quantity of wine, and then a few drops of a solution—usually about 12 or 15, 8 parts to 100 of water—of carbonate of ammonia were poured in. A precipitate of alumina is immediately produced, variously coloured, according to the nature of the colouring matter employed. An excess of the precipitant must not be added, for in that case the tints produced are not sufficiently marked to allow of the discrimination of the substance employed. The action is most marked after the lapse of seven or eight minutes.

Method of Nees Van Esenbeck.—The process of Nees Van Esenbeck is but a modification of the preceding method, that chemist using alum and carbonate of potash.

These reagents, with *normal wine*, give a dullish grey precipitate having a more or less decided red tinge. An excess of alkali redissolves part of the precipitate, the remainder being ash grey. If the wine be new, the residuary precipitate possesses a greenish tinge.

Wine coloured with the colouring matter of the petals of *red poppy* gives a brownish grey precipitate which becomes black by excess of alkali.

Coloured with *privet berries*, it gives a brownish violet precipitate.

Coloured by *elder berries*, a violet precipitate; by *Brazil wood*, a greyish violet; and by *logwood*, a rose coloured precipitate.

It therefore follows, from the experiments of Nees Van Esenbeck, that all those wines, which give with the reagents above named bluish violet or rose coloured precipitates, are artificially coloured or adulterated with foreign colouring matters.

The reagents must be employed by means of solutions of definite strength—namely, one part of alum to eleven of water, and for the other solution one part of carbonate of potash to eight parts of water; the wine and the alum solutions are to be mixed together in equal proportions, and the solution of potash gradually poured in, until the whole of the alumina is precipitated.

On the Detection of Lead in Wine.—If the wine be of light colour, a portion of it, about ten ounces, may be evaporated down to one ounce, and this may be divided into two parts, one being tested with sulphuretted hydrogen, which will give a black precipitate if lead is present, and the other with a solution of iodide of potassium, which will give rise to the formation of a yellow iodide of lead. Or the same quantity of wine, either red or white, may be evaporated to dryness, and the residue incinerated: the destruction of the carbon and the oxidation of the metal is rendered more complete by ignition of the residue with about twice its weight of nitre. After fusion, the residuum must be digested with a little dilute nitric acid, the solution evaporated nearly to dryness, the residue treated with distilled water, and the solution filtered and tested with the reagents above named. For fuller particulars refer to the articles on Annatto, Sugar Confectionery, and Snuff.

On the Detection of Copper in Wine.—Copper is sometimes present in wine from natural causes, being in such cases derived from the grapes from which the wine is made; sometimes it is purposely introduced. M. Perette undertook some very interesting investigations, which will be found recorded in the work "On the Falsification of Alimentary Substances," by MM. Garnier and Harel, in order to determine whether some method might not be devised by which the cases of the presence of the metal from natural causes might be discriminated from those in which it had been purposely introduced into the wine; and in attaining this end M. Perette appears to have been successful.

M. Perette took 10 lbs. of perfectly pure red wine; this he divided into two parts, one was decolourised by animal charcoal, evaporated to one fifth, treated again with charcoal, and rendered still more concentrated by evaporation. To a little of the liquid poured into a test tube, a few drops of a solution of ferrocyanide of potassium were added, but no change of colour ensued, neither did any precipitate take place. In another portion of the decolourised liquid a plate of polished iron was plunged for some time, but no deposition of copper occurred.

The other 5 lbs. of wine were evaporated to dryness, the residue incinerated, treated with nitric acid, and after evaporation to dryness the residue was dissolved in water; a plate of iron plunged into a portion of the solution became rapidly coated with copper, and the solution of ferrocyanide of potassium, added to another portion of the solution, gave an immediate iron red colouration, which after a time became violet, denoting the presence of iron.

M. Perette next added one grain of oxide of copper to another 5 lbs. of wine, and treated it by decolourisation and evaporation, and then tested it with one drop of solution of ferrocyanide of potassium when the whole assumed a rose red tint, and after a time a precipitate of the same colour formed without any indication of the presence of iron, as shown by the formation of a portion of prussian blue.

The iron naturally present in the wine, M. Perette subsequently proved, had been removed by the charcoal with the colouring matter.

M. Perette further ascertained that if the residue obtained by the evaporation of wine be carbonised, and the carbonaceous matter treated with water containing a little ammonia, the liquid will remain colourless in the case of normal wine, but will become blue if oxide of copper has been added to the wine in the proportion of one grain to 5 lbs. of wine.

Liebig has the following remarks in regard to the value of wine:—

"As a restorative or means of refreshment, where the powers of life are exhausted; of giving animation and energy, where man has to struggle with days of sorrow; as a means of correction and compensation where misproportion exists in nutrition, and the organism is deranged in its operation; and as a means of protection against transient organic disturbances, wine is surpassed by no product of nature or of art.

"The nobler wines of the Rhine, and many of those of Bordeaux, are distinguished above all others by producing a minimum of injurious after-effect. The quantity of wine consumed on the Rhine by persons of all ages, without perceptible injury to their mental and bodily health, is hardly credible. Gout and calculous diseases are nowhere more rare than in the district of the Rhinegau. so highly favoured by nature. In no part of Germany do the apothecaries' establishments bring so low a price as in the rich cities on the Rhine; for there wine is the universal medicine for the healthy as well as the sick; it is considered as milk for the aged."

We gather, from the evidence before the Committee on Adulteration, the following particulars in regard to the proceedings of the Excise as to wine: —

Mr. Villiers. "How does foreign wine come within your province to examine?" — "I cannot tell; we have had *two* samples, one in the year 1850, and one in 1852."

"Are there any tasters appointed for the wine brought into this country?" — "We have none."

Mr. Moffatt. "The wine is under the Customs, is it not?" — "Yes, and the dealers have to pay a license to us."

Mr. Villiers. "Are British wines much adulterated?" — "British wines are made up in a variety of ways; we do not interfere with them much."

So much for the efficiency of the Excise in regard to wine. It appears that two samples were examined in twelve years.

The Customs' duty on wine from British colonies, certified to be the production of those colonies, is 2*s.* 9*d.* per gall., with 5 per cent. thereon; all other wines 5*s.* 6*d.* per gall., and 5 per cent. thereon.

The quantities entered for home consumption were —

	In 1854.	In 1855.	In Nine Months of 1856.
	Galls.	Galls.	Galls.
British Colonies: red - - -	153,279	152,069	134,472
Foreign: red - - - -	3,096,052	2,756,750	2,171,099
British Colonies: white - - -	125,739	111,116	113,272
Foreign: do. - - -	3,518,213	3,424,185	2,828,371
Various mixed in bond: red - -	177,833	138,616	112 847
" " " white - -	78,496	87,622	70,583
Total - - - -	7,149,612	6,670,358	5,430,644

PART II.

DRUGS, AND THEIR ADULTERATIONS.

The subject of the adulteration of drugs has already been briefly touched upon in the introduction to the work; the system of drug grinding, and the effects of adulteration in impairing the efforts of the physician to cure disease were especially alluded to.

The prevalence of adulteration may be proved in several ways.

First, by the actual analysis of various drugs: the results of some hundreds of such analyses we shall shortly proceed to record.

Second, by the testimony of competent witnesses.

Third, by the system of drug grinding.

Fourth, by the existence of what are known as compound powders.

Fifth, by the prices at which various drugs are sold.

Referring to the evidence given before the Parliamentary Committee appointed to inquire into the subject of adulteration, we meet with much valuable testimony in regard to the falsification of drugs, and some of which we shall now quote.

Some idea of the extent to which adulteration prevails may be formed from the evidence elicited from Dr. R. D. Thomson by Mr. Villiers.

"All the drugs are submitted to some examination, are they, at St. Thomas's Hospital?"—"Every one."

"Have you often rejected drugs?"—"Very frequently indeed. I may say that one third of the substances I have examined I have rejected, either from impurity or adulteration."

Mr. Herring, a wholesale chemist and druggist, of the highest character, engaged in the drug trade for forty years, thus deposes to the prevalence of adulteration in drugs.

Mr. Scholefield. "Will you favour the Committee with your view as to the existence of adulteration in the article of drugs?"—"It exists to a very great extent."

Referring to Mr. Redwood's denials of adulteration before the Committee, Mr. Villiers asked Mr. Herring the following question:—

"It is the opinion of a gentleman connected with that Society* that there is very little impurity in drugs, and what there is is not at all injurious?"—"I cannot agree with that."

"Have you any experience of the supply of drugs to Poor Law Boards?"—"We never did it, but I have seen a great deal of it; and there the powdered article will be 100 per cent. cheaper than the staple article."

Mr. Scanlan, a chemist of repute, engaged for many years in the manufacture of drugs and chemicals, gave the following evidence as to the general adulteration of drugs:—

Mr. Scholefield. "The general effect of your evidence is that there is a considerable amount of adulteration in drugs?"—"In drugs and chemicals used in medicine."

"And therefore considerable risk exists that the prescriptions of physicians will not have their intended effect upon their patients?"—"There is no doubt of it. I heard Mr. Redwood's evidence, and I do not think he admitted adulterations to the extent to which they really exist."

It appears from the following remark of Dr. Thomson made to the Committee on Adulteration that any powder, no matter what its real value and original cost, might at one time have been bought for 36*s.* per cwt.; this single fact of itself proving the extensive practice of adulteration.

Mr. Villiers. "I suppose there is some difference of price between the best drugs and those which are inferior and adulterated, is there not?"—"I have been told that there are druggists, at least one druggist, who would sell any powder you pleased at 36*s.* the cwt."

The following information was elicited by Mr. Villiers from Mr. Warington in regard to adulteration on the part of drug grinders:—

"You say you generally grind your own drugs. From inquiries which you have made in the trade is it your opinion that a great deal of adulteration takes place on the part of the grinders?"—"We were forced to grind our drugs by the fact of the adulteration. Even when the Society of Apothecaries sent a man to the drug mill to superintend the grinding of their own drugs, he was taken down to dinner or to lunch, or to something of the kind, and all kinds of tricks were played with their drugs."

Mr. Bastick, whose attainments in pharmaceutical chemistry are unequalled by any other chemist in this country, furnished the Committee with the following evidence in regard to the adulteration of the articles known as *compound powders*:—

"There is a class of bodies I should wish particularly to draw the attention of the Committee to, which is a series of powders vended by wholesale druggists, which they are pleased to term compound powders. Those powders, if they were properly designated, would be called adulterated powders. They are obliged to use a term in contradistinction to that of compound powders, and they employ the word '*verus*.' If, for example, you wished to order genuine aniseed powder, you would ask for *pulvis anisi verus:* but if you wanted the adulterated powder you would ask for *pulvis anisi compositus.* The most frequent instances of these adulterated powders are aniseed, carraway seeds, fenugreek seeds, liquorice, gentian, turmeric, and stavesacre. The recipe which I propose to read to the Committee for compounding one of these powders is only a type of many others. It is in a book which I have in my hand, which belonged to a person who used to manufacture these powders who is now dead, and therefore I feel no delicacy in reading it. The following are the materials for making compound gentian powder: true gentian, 1 lb., linseed, 5 lbs., flour, 2 lbs., cape aloes, to give the bitterness, a sufficient quantity; that is the recipe employed to make gentian powder *compositus*."

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* The Pharmaceutical Society.

Chairman. "If I understand rightly, there are 7 lbs. or 8 lbs. of material, having only 1 lb. of the genuine article in it?"—"Yes."

Mr. Sheridan. "Who are the parties who apply for *pulvis compositus?*" — "The retail druggist; it is a conventional term between the retail and the wholesale druggist, invented to avoid the disagreeableness of talking about adulterated articles."

"'Any medical man using gentian made up according to that receipt, would find his expectations totally fail?" — "Entirely."

Mr. Sheridan. "The wholesale druggist compounds the powder?"— "In most cases it is done by him, or by the drug grinder on his behalf."

Chairman. "What would be the relative selling price of the true gentian and the *compositus?*"—"A wholesale druggist would speak to that better than I can; of course there is a considerable reduction. I will mention one other instance of the composition of a compound powder, that is turmeric: common ochre, 1 lb., true turmeric, 1 lb., flour, 2 lbs."

"That is in the proportion of one to four?" — "Yes."

"You alluded just now to the use which has been made of the term 'conventional adulteration;' * do you consider the practice you have now referred to as conventional between the druggist and the drug grinder, or between the wholesale druggist and the retailer?" — "Yes, between the wholesale druggist and the retailer; certainly not as regards the public."

"The drug grinder and the retailer understand each other, and therefore it may be said to be a conventional arrangement between them; but do the public, when they purchase these powders, understand that there is this admixture in the one case of four to one of foreign material, and in the other of seven to one of foreign material?"—"Certainly not."

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* This remarkable expression was first employed by Mr. Redwood in defence of adulteration.

"Does a medical man who prescribes those powders expect to find those proportions?"—"Certainly not."

"Then, although this may be a conventional matter between a portion of the trade, the public is literally defrauded?"—"Undoubtedly; nor do I believe that the public in any instance are a party to any adulteration, or willingly purchase an article which is adulterated."

Now these compound powders form part of the stock of nearly all wholesale druggists, including even many of the most respectable. We have now in our possession samples of all these powders supplied to us by one of the first houses in the drug trade. Notwithstanding this notorious fact, that they are thus commonly kept and sold, Mr. James Baiss, after fencing a good deal with the Committee, gave the annexed reply to a question by Mr. Moffatt:—

"You are not aware of that article (compound gentian powder) being one of the current articles in the drug trade."—"It would only be in very rare instances."

We affirm that there is scarcely another wholesale chemist and druggist in the kingdom who would have ventured upon a similar statement.

It is urged in defence of the manufacture of these powders, that they are exclusively used as cattle medicines. This statement is most incorrect, in proof of which we need only refer to the articles on Turmeric and Liquorice powders. Besides, why should adulterated powders containing large quantities of starch, yellow ochre, &c., be thrust down the throats of cattle any more than of human beings?

Mr. Gay, a witness before the Parliamentary Committee, from whose evidence we have before had occasion to quote, gave the following answers to questions by the Committee, having reference to adulteration by drug grinders:—

"I was employed a long time in what is called a grist mill, and we split upon the average something like 60 or 70 quarters of beans a day. Egyptian beans contain a great deal of dirt; if a man sent us 100 stone of Egyptian beans, when we washed the dirt out, they would be reduced 5 stone, leaving 95. We asked the person who sent them, 'How much do you expect to be returned out of the 100 stone?'—"If he said he wanted 110, there being 5 stone lost in dirt, there must be 15 stone more sent to him than he actually sent to the mill, though it is not injurious to health, because it is 15 stone weight of water."

"You added the weight by soaking the beans in water?"—"Yes; we were compelled to do it; he sent so many hundredweight to be split, and told us he wanted so many hundredweight back; that is done by what is called in the trade 'washing,' with a view to wash the dirt out."

Mr. Sheridan. "Have you had drugs also to grind in the same way?"—"Yes."

"How long ago was that?"—"I think it is about three years since my place was burnt down."

"What kind of proportion did the person who sent the drugs to you to be ground require back?"—"It depended upon the parties. Take the case of rhubarb; whatever may be said about English rhubarb being sold to the public as English rhubarb, it is mostly sold under the name of Turkey rhubarb, there is no question about that; I have had 5 cwt. of rhubarb sent to be ground, perhaps 2 cwt. would be Turkey, and 3 cwt. English rhubarb."

Chairman. "In the ground state?"—"Yes."

Mr. Sheridan. "Supposing a hundredweight of Turkey rhubarb were sent to be ground, would a hundredweight be returned?"—"No."

"Who suffered the loss?"—"The proprietor; perhaps he would make it up with inferior rhubarb."

Chairman. "There was no attempt to supply the waste by any other material?"—"Yes; I have seen that done by satinwood sawdust. I have in my mind a case in which two hundredweight of satinwood sawdust were ground up with rhubarb, packed in flint bottles, and sent abroad."

Mr. Sheridan. "Do you mean to say that that is the custom of the trade?"—"I do not say that it is the custom of the trade. I have ground but few things genuine, as far as my experience has gone."

Mr. Kinnaird.—"How long were you in business?"—"I was thirty years a mustard, chicory, drug, and spice grinder."

"During that time you very seldom sent forth a pure article?"—"No."

"Can you say whether adulteration has been rather on the increase during the last few years you were in business?"—"I am sure it has; new things have been found out, which years ago we knew nothing of, to adulterate with."

Mr. Sheridan. "Had you any book?"—"I had a book till my place was burnt down, which gave the detail of every transaction from the time I went into business. I made no scruple to show it. I have done as much in the way of adulteration as any man in the trade, and I have done more than almost any other man to expose it. I have done it in defiance of my employers, with a view to crush it; and I have felt exceedingly glad to have an opportunity of giving it a severe blow. I believe many honest men will thank any one who will put an end to it."

"Do you mean to say that it was a general instruction you had from those houses to mix other ingredients with the drugs?"—"I cannot say that I had one customer on my books but what has been compelled to mix more or less."

"Still your experience as a drug grinder leads you to say that it is the prevalent practice with the wholesale druggists to send two substances to be mixed together, to be sold as one article?"—"I have found it so."

Mr. Moffatt. "As a drug grinder were you ever called upon to introduce any other substance into a drug before you sent it home?"—"Yes; sometimes the adulterate has been sent to me to mix, and sometimes they have sent to me to say, 'Put in so-and-so, and charge for it.'"

"Were those instructions applicable to a great variety of drugs?"—"To rhubarb, jalap, and cocculus indicus; I have ground many cwts. of cocculus indicus."

"And you have worked for a great number of respectable wholesale druggists?"—"I have worked for a great number of respectable wholesale druggists in the country, where my mills were."

"Where were your mills?"—"Near Leeds."

"Have you had any experience with regard to drug grinding in London?"—"I have ground a good bit in London."

"Does your evidence apply also to the London druggists?"—"Yes; that case of the rhubarb being mixed with satinwood sawdust occurred in London."

The evidence of Mr. Bell, given before the Parliamentary Committee, in regard to the practice of drug grinders is particularly valuable, as coming from one who, like his friend Mr. Redwood, has on more than one occasion sought either to deny the existence of, or to palliate and excuse adulteration:—

"Are you of opinion that a great deal of adulteration takes place among drug grinders?"—"I think some adulteration does, but not nearly so much as was the case some years ago; it was formerly the custom to send fourteen pounds of a drug to be ground and receive a quarter of a hundredweight, and sometimes half a hundredweight back; but that custom, I believe, is entirely discontinued.

Mr. Wise.—"Have you not heard, and is it not a frequent occurrence, that persons are sent in charge of drugs which are to be ground, so as to watch that no adulteration takes place?"—"I have not heard of that as a frequent occurrence. I should be very sorry to employ a person to grind drugs who required looking after in that way; it may have been done. *Till very recently*, it was always the case that persons expected to receive *the full* quantity back in powder, without any allowance for loss in grinding."

A few other facts may now be cited in further proof, if any were needed, of the extensive prevalence, till within a recent period, of adulteration in drugs.

The Americans found that the drugs imported into the Union from this country were so infamously adulterated, that in self-defence they were driven to appoint inspectors and examiners in some of the places of import. Still later, the Spaniards discovered that they were subjected to the same imposition, and were compelled to adopt measures of precaution of a like character.

The quantities of damaged and adulterated drugs rejected by the Americans is really marvellous, as will be seen by reference to the evidence given by Mr. Jacob Bell before the Parliamentary Committee.

We will now state at length the results derived from the microscopical examination and chemical analysis of some of the principal drugs, under which head we include Tobacco.

TOBACCO, AND ITS ADULTERATIONS.

Tobacco consists of the dried leaves of several different species and varieties of plants belonging to the genus *Nicotiana*, of the family *Solanaceæ*, which includes, amongst other medicinal plants, hyoscyamus, belladonna, and stramonium.

The tobacco plant, according to Humboldt[*], has been cultivated from time immemorial by the natives of Oronoko, but its introduction into Europe appears to have taken place subsequent to the discovery of America, although there is reason for believing that it was known to the Asiatics long before that time.

The custom of smoking cigars was beheld by Columbus and his followers for the first time on their arrival at Cuba in 1492.[†] The plant was introduced into Spain and Portugal by Hernandez de Toledo, and Joan Nicot about 1559-60 sent the seeds from the latter place to France.[‡] On the return of Sir Francis Drake with the colonists from Virginia in 1586, the practice of smoking was introduced into England, and soon became general, Sir Walter Raleigh being one of the first to adopt it.[§]

Subsequent to its introduction into Europe, various attempts were made to prohibit the smoking and use of tobacco; but all the writings, pains, and penalties proved ineffectual, and the practice went on extending, until, as at present, it has become almost universal. One of the most celebrated of the treatises written against tobacco was the "Counterblaste to Tobacco,"[‖] by King James the First.

In Great Britain the cultivation of tobacco is still restricted on account of the revenue, not more than half a pole (two yards and three-quarters) being allowed "in a physic or university garden, or in any private garden for physic or chirurgery."

The generic appellation of *Nicotiana* is evidently derived from Nicot, the name of the individual by whom the plant was first sent to

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[*] Personal Narrative, vol. v. p. 666.

[†] History of the Life and Voyages of Columbus, Washington Irving, vol. i. p. 287.

[‡] Bauhin's Pinax. [§] Biograph. Brit. vol. v. p. 3471. [‖] Works, p. 214. f. 1616.

France, while it is probable that the specific word *tabacum* given to one of the principal species, is derived from *tabac*, the name of the instrument used by the natives of America for smoking tobacco. Some, however, derive the word from Tobago, others from Tobasco, a town in New Spain.

The principal species of tobacco, and also that employed in medicine, is *Nicotiana Tabacum*, or *Virginian tobacco;* it is a herbaceous plant, reaching from three to six feet in height, with a viscid, gummy juice; the leaves are sessile, large, pale green when fresh, oblong, lanceolate, acuminate, and clothed with short glandular hairs; it is extensively cultivated nearly all over the world, but chiefly in the United States of America, Virginia being the most celebrated for its growth.

Of this species several varieties are cultivated; Virginian, Kentucky, Maryland, and Columbian tobacco, are all obtained from it.

The leaves of *N. latissima* (Miller), *N. macrophylla* (Sprengel), yield the *large-leaved* or *Oronoko tobacco.* This is probably merely a variety of the preceding species; it likewise presents certain modifications or varieties dependent upon the size and form of the leaves, as also upon whether they are sessile, or furnished with leaf-stalks. According to Don the large Havannah cigars are probably made from the leaves of this species.

The leaves of the *N. rustica*, *common green tobacco*, furnish the tobacco of Salonica or Thessalonica; also the Turkish tobacco grown on the coasts of the Mediterranean, so highly valued in India; and probably also the celebrated Latakia. The leaves of this species are petiolate, ovate, and quite entire. It ripens earlier, and is more hardy than *N. Tabacum.* It is frequently cultivated in gardens in England, and is used by gardeners to destroy insects. It is indigenous in America, and grows wild in Europe, Asia, and Africa.

N. Persica (Lindl.) yields the celebrated Shiraz or Persian tobacco. Of the leaves of *N. repanda* (Willd.), a native of Cuba, near Havannah, the small Havannah or Queen's cigars are said to be made.

N. quadrivalvis (Parsh.) grows spontaneously, and is also cultivated on the banks of the Missouri by the Indians. The tobacco prepared from it is described as excellent; the most delicate is made from the dried flowers.

N. nana (Lindl.) grows in the Rocky Mountains; the Indians are said to prepare the finest of their tobacco from the leaves of this species.

The last species which need be noticed is *N. multivalvis*, cultivated by the Indians who inhabit the banks of the Columbia; the calyx, which is very fœtid, being preferred to any other part.

The tobacco plant is propagated in Virginia and Maryland from seeds. These are first sown in beds: as soon the young plants have five or six leaves, exclusive of the seminal leaves, they are transplanted, during the month of May, into fields, the seedlings being placed two or three feet apart, in rows. When nearly full-grown, the tops are pinched off, to prevent the formation of flowers and seeds, and to promote the development of leaves. The harvest takes place in August; the mature plants are cut off above the roots, dried under cover, and stripped of their leaves, which are tied in bundles and packed in hogsheads, &c.

Tobacco is met with in two states—the "RAW" or "UNMANUFACTURED," and the "MANUFACTURED."

Tobacco in the raw state consists merely of the dried leaves; these, as imported, are sometimes separate, and placed one upon the other, as in Turkey tobacco; at others they are strung on strings, as in German tobacco; but usually they are imported in "heads," or "hands," as they are termed; the different varieties of American tobacco come over in this state.

There are various kinds of dried leaf, or unmanufactured tobacco, distinguished by the name of the country in which it is grown, as well as by differences of colour and quality, arising chiefly from soil and climate.

UNITED STATES TOBACCO.—The principal supplies of tobacco to this country are derived from the United States of America, the several kinds being named after the states in which they are grown—as *Virginian*, *Kentucky*, *Maryland*, *Missouri*, *Ohio*, and other descriptions, all cultivated in, and imported from, the United States.

Virginian Tobacco is the strongest kind of tobacco, and is not, therefore, well suited for cigars; it is best adapted for smoking in pipes and for snuff. The colour of the leaves is deep brown, and they present a mottled appearance; they feel unctuous, and are so tough that they may be bent double without breaking, when not over-dried. Since this tobacco will retain more moisture than almost any other kind, and since its strength is much greater, it is extensively used by tobacco manufacturers.

Maryland Tobacco is paler in colour and weaker than the former; the "*pale Cinnamon*" is the best, the "*Scrubs*" the commonest.

Kentucky Tobacco is described as being intermediate in strength between these; it is paler than the Virginia.

Carolina Tobacco is less frequently met with, and is of inferior quality.

Columbian Tobacco is much esteemed for cigars, for which it is more used than any other kind. The leaves are marked with light yellow spots. Other varieties of Columbian tobacco are, *Varinas*, brought over in rolls and heads, a very mild tobacco, and *Cumana*.

ORONOKO TOBACCO comes over in separate leaves; it is of a yellow colour, and is very mild and delicate.

CUBA TOBACCO is also a mild tobacco, and the most esteemed for cigars; that grown near the town of *Havannah* is the finest; the leaves of this are yellowish brown, with a musky or spicy odour. The ordinary tobacco grown on the island is darker than the Havannah. Both kinds are imported in heads, and are remarkable for the light yellow spots on the leaves.

St. Domingo Tobacco comes over in separate leaves, and is of inferior quality.

Brazilian Tobacco.—A very small quantity only of this tobacco is imported from the Brazils.

Dutch or Amersfoort Tobacco is very mild, and deficient in flavour; the darker kind is the strongest, and is much used for snuff; while the mildest is employed for the commonest cigars.

Levant Tobacco includes *Turkey*, *Latakia* (a Syrian tobacco), and *Salonica* tobacco; these are all the produce of *Nicotiana rustica;* they are mild, but valuable tobaccos. *Turkey* tobacco comes over in broad and separate leaves, of a bright yellow colour.

Persian or *Shiraz Tobacco* is also a Levant tobacco; it is delicate and fragrant, and is the produce of *Nicotiana Persica.*

Another description is East India Tobacco, of which a small quantity only is imported; it is not much esteemed.

Manilla Tobacco, grown near the town of Manilla, in Lucon, one of the Philippine Islands, is a dark-coloured tobacco, and is extensively used in the manufacture of cheroots.

In the hands of the manufacturer the leaf is converted into *manufactured tobacco* in the following manner:—

The leaves are unfolded and "stripped"—that is, the mid-ribs or stalks are removed; this is done by a sudden jerk of the stalk by the hand, holding by the leaf. They are then sprinkled with "sauce" or "liquor;" this, properly, should consist of water only, but in some cases it contains salt, and is coloured with treacle or liquorice; but these additions are adulterations. After the sprinkling, by which the leaves imbibe a good deal of the liquor, and therefore become increased in weight, they are put into large, flat, square, iron boxes, and pressed into a solid cake; during the pressure, if too much "liquor" has been used for the sprinkling of the leaves, some escapes, deeply coloured with extractive derived from the tobacco leaf. This mixed with the washings of the cloths used in pressing, is sold as "tobacco water," and is used as a sheep-wash, and also by gardeners to destroy worms and other vermin. The cake is then cut into shreds with knife-edged chopping-stamps, the shreds varying in diameter of from sixteen to one hundred to the inch. Lastly, the tobacco in this state is lightly dried or "stoved" in a flat copper or iron tray, heated by sand, and frequently by steam.

The above process of course applies only to cut or shag tobacco; in the manufacture of "roll tobacco" a totally different method is followed:—

The leaves, or rather the half-leaves, are arranged end to end in a line down a long table; this is mostly done by women or boys. One of the leaves, having first been twisted into a kind of thin rope, is attached to an iron hook, which is made to revolve rapidly, by means of a wheel, in a horizontal position on a level with the surface of the table. The "spinner" then, with a small board fixed to the palm of the hand, while the rope is turning, attaches leaf after leaf, rolling and hardening it with the board as the length proceeds. When sufficient is manufactured, the rope is coiled up so as to form a barrel-shaped pile or mass, each layer being well oiled with a brush, to prevent the coils from adhering to each other. The coils being firmly pegged together with wooden nails, the whole pile is then steeped in "liquor," and firmly pressed, oiled, and polished with a brush. It is estimated that this kind of tobacco increases in weight in the manufacture from fifteen to twenty-five per cent.

All manufactured tobaccos may be referred to one or other of the four following forms or kinds: —

In the first kind the leaves are cut into shreds; to this all the different varieties of *cut tobacco* belong.

In the second, the leaves are twisted or spun into a kind of rope; this includes the different kinds of *roll*, *spun*, or *twist tobacco*.

In the third, the stripped leaves are folded one over the other, so as to form *cigars* and *cheroots*.

In the fourth form, the leaves are reduced to powder, constituting *snuff*.

We need only describe at present the different varieties of cut and roll tobacco: —

The chief kinds of cut tobacco are *Shag*, *Returns*, and *Bird's-eye;* other less common kinds are *Maryland*, *K'Naster*, *Oronoko*, *Turkey*, *Persian*, and *Varinas*.

Shag is prepared chiefly from Virginia and Kentucky tobacco.

Returns is a light-coloured, mild tobacco. The true derivation of its name is said to be, that formerly the tobacco known as "*short cut*" was with much labour rubbed through a wire sieve; the finer portions and dust, technically called "smalls," passed through, and were supposed to be much the strongest; when no more would go through, that which was left upon the sieve was reckoned to be milder, and of superior quality, and called in the trade "Returns." According to Pereira its name is derived from its being formerly prepared by returning shag for re-cutting. In the Report on the Tobacco Trade, by the Select Committee of the House of Commons, made in August 1844, it is described as "made up of the small pieces of broken leaves, and the dust and siftings produced in the various processes of manufacture."

Bird's-eye differs from the other varieties in containing the midribs of the leaves, the transverse slices of which have been fancifully compared to the eyes of birds.

The principal kinds of roll tobacco are *Pigtail*, *Bogie*, *Alloa*, *Negrohead*, and *Cavendish*.

The first three are used entirely for chewing, and are distinguished by the difference in the thickness of the ropes, *Alloa* being the thinnest and *Bogie* the thickest.

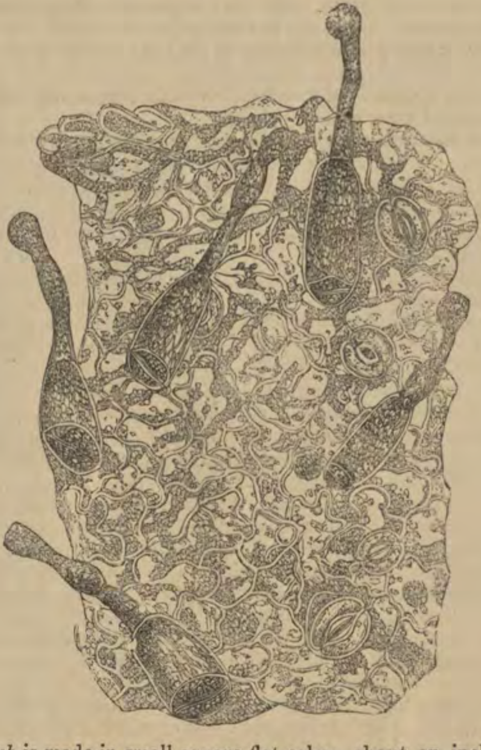
Negro-head and *Cavendish* are used nearly exclusively for smoking.

Negro-head is manufactured in the form of a thickish rope; it also sometimes consists of two ropes coiled together in short pieces.

Fig. 184.

UPPER SURFACE OF LEAF OF TOBACCO.

(Magnified 220 diameters.)



Cavendish is made in small square flat cakes, about an inch and a half wide by five inches long.

Structure of Tobacco.

The leaves of tobacco present several well marked *peculiarities of structure*, by which they may be readily distinguished, even in their manufactured state, from those of most other plants. These peculiarities can only be satisfactorily determined by means of the microscope, and it is very important that they should be clearly understood, for without a knowledge of them it is often impossible to discriminate between genuine and adulterated tobacco—a point of the greatest consequence, since no less than about four millions and a half pounds sterling are derived annually from the duty on tobacco, and since it is known that the revenue is defrauded to a large extent with comparative impunity by the adulteration of tobacco. Most leaves may be divided into two parts, the broad expanded part or lamina, and the mid-rib or stalk and veins, as they are called, which traverse this, imparting to it strength and solidity in the same way as do the bones of an animal.

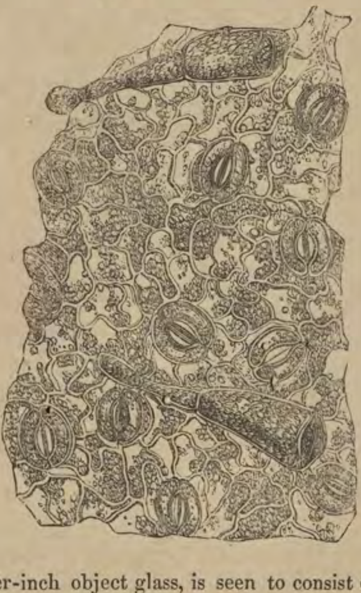
The lamina is composed chiefly of cellular tissue, and the veins of woody fibre and vessels.

A minute fragment of tobacco leaf, viewed on its upper surface with a half or quarter-inch object glass, is seen to consist of a number of cells, joined together, and having smooth and waved borders, with

Fig. 185.

UNDER SURFACE OF LEAF OF TOBACCO.

(Magnified 220 diameters.)



here and there stomata and numerous hairs. These hairs are peculiar; they are of the kind termed glandular—that is, they terminate in a roundish swelling or enlargement, very clearly seen even in the dried leaf; further, the hairs vary greatly in size, and occasionally they are divided or compound. *Fig.* 184.

The under surface of the leaf presents a nearly similar structure, but the stomata are much more numerous, and the hairs fewer. *Fig.* 185.

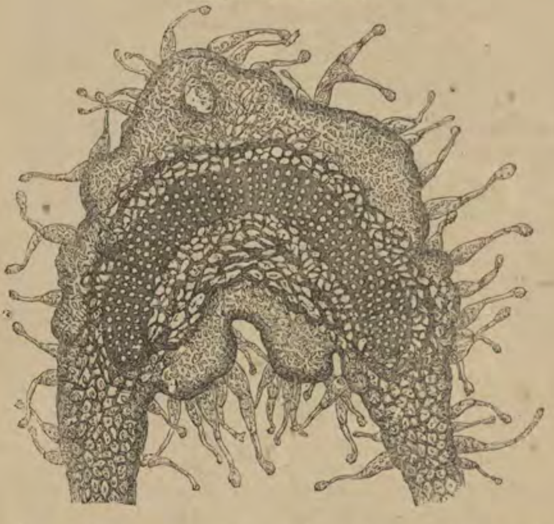
The veins and mid-ribs, viewed in transverse sections, are of a crescentic or horseshoe form. It has been considered by some that the stalks of tobacco may always be distinguished from those of other plants by this character. It appears, however, that sections of the stalks of stramonium and hyoscyamus present a nearly similar outline; but these plants are scarcely likely to be used, under any circumstances, by the manufacturer, for the adulteration of tobacco.

Transverse sections of the smaller veins under an inch object-glass present the appearances shown in the following figure.

Fig. 186.

TRANSVERSE SECTION OF MID-RIB OF LEAF OF TOBACCO.

(Magnified 40 diameters.)



On the outside, running all round the section, *fig.* 186., is a layer of the cellular tissue of which the lamina of the leaf is itself mainly composed, bearing on its outer surface the gandular hairs; in the centre of the section, the cut extremities of the elongated cells, woody fibre, and dotted ducts, of which the stalks are chiefly made up, are seen, having a somewhat radiated disposition. These structures are more clearly shown in *fig*. 187.

Fig. 187.

PORTION OF TRANSVERSE SECTION OF MID-RIB OF LEAF OF TOBACCO.

(Magnified 90 diameters.)

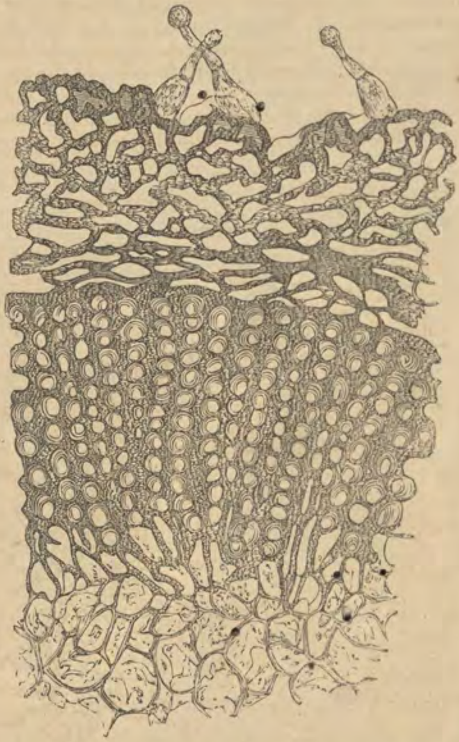


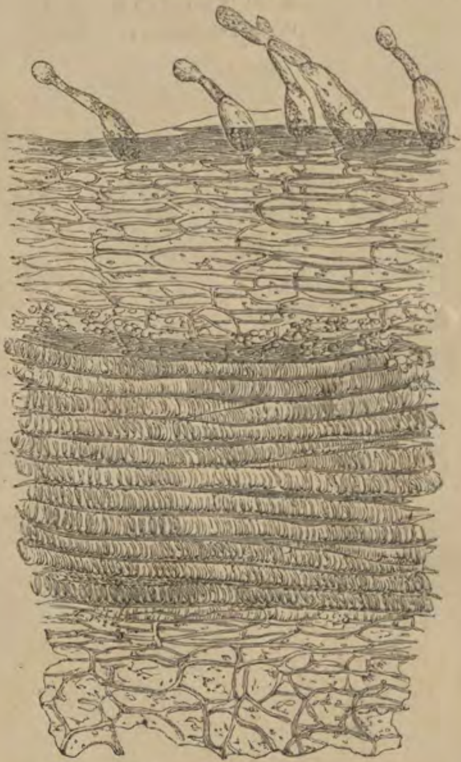
Fig. 188. represents a longitudinal section of one of the smaller mid-ribs, in which the cells, fibres, and vessels are still more clearly shown.

In longitudinal sections viewed with the quarter-inch object glass, a few small but well-formed starch corpuscles may sometimes be seen lying in the cells situated just outside the central part of the mid-rib.

Fig. 188.

LONGITUDINAL SECTION OF MID-RIB OF LEAF OF TOBACCO.

(Magnified 90 diameters.)



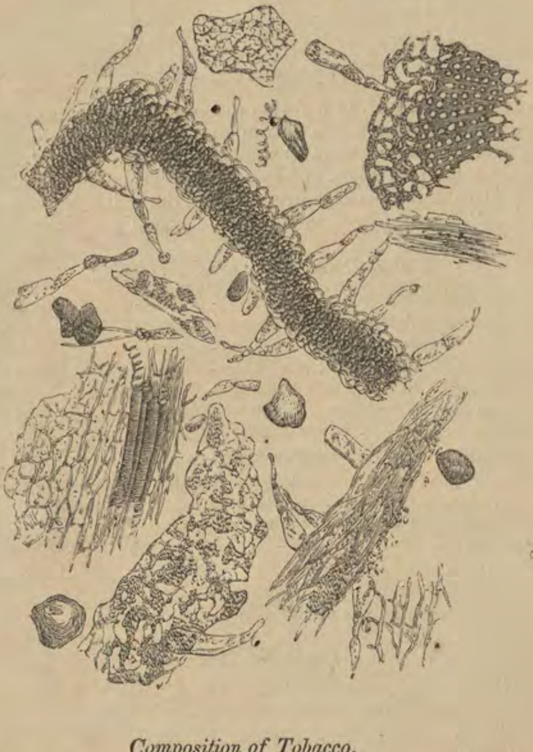
In the leaf of tobacco reduced to powder all the above structures may be readily detected, — of course much broken up, — as the hairs, cells of the lamina, stomata, elongated cells, woody fibre, and portions and fragments of the spiral ducts. *Fig.* 189.

The quantity of woody fibre present in the central part of the mid-rib is by no means very considerable, it being made up to a great extent of the spiral ducts; the fibres, in general, are more like elongated cells than ordinary woody fibres; nevertheless, bundles of undoubted woody fibre do occur. The fibres are short, the borders striated, and the extremities truncate.

Fig. 189.

GENUINE CUT TOBACCO

(Magnified 40 diameters.)



Composition of Tobacco.

We have now to consider the *composition* and *properties* of tobacco. The principal analyses of tobacco which have hitherto been made are the following:—

Vauquelin's Analysis.[*]

An acrid volatile principle (*nicotina*).
Albumen.
Red matter soluble in alcohol and water.
Acetic acid.
Supermalate of lime.
Chlorophylle.
Nitrate of potash and chloride of potassium.
Sal ammoniac.
Water.

Expressed Juice of Leaves.

The *leaves* contained, in addition to the above, woody fibre, oxalate and phosphate of lime, oxide of iron, and silica. The two latter substances were obtained from the ashes. *Manufactured tobacco* contained the same principles, and in addition carbonate of ammonia and chloride of calcium, perhaps produced by the reaction of sal ammonia and lime, which are added to tobacco to give it pungency.

Possell and Reinmanns' Analysis.[†]

Nicotina	0·06
Concrete volatile oil	0·01
Bitter extractive	2·87
Gum with malate of lime	1·74
Chlorophylle	0·267
Albumen and gluten	1·308
Malic acid	0·51
Lignin and a trace of starch	4·969
Salts (sulphate, nitrate, and malate of potash, chloride of potassium, phosphate and malate of lime, and malate of ammonia)	0·734
Silica	0·088
Water	88·280
Fresh leaves of tobacco	100·836

Conwell's Analysis.[‡]

Gum.
Mucilage soluble in both water and alcohol.
Tannin.
Gallic acid.
Chlorophylle.

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[*] Ann. de Chim., vol. lxxi. p. 139.
[†] Gmelin's Handb. de Chem. vol. ii. p. 1303.
[‡] Silliman's Journal, vol. xvii. p. 369.

Green pulverulent matter, soluble in boiling water.
Yellow oil having the odour, taste, and poisonous properties of tobacco.
Pale yellow resin (large quantity).
Nicotina.
A substance analogous to morphia.
An orange red colouring matter.
Nicotianin.

Of the several constituents, the presence of which has been revealed by chemical analysis, the most important are nicotina or nicotine, and nicotianin, as upon these the active properties of tobacco mainly depend.

Nicotina exists not only in the leaves, both fresh and fermented, but in the roots, seeds, and even the smoke of tobacco. It is obtained by digesting an aqueous extract of the leaves in rectified spirit; this takes up the nicotina in combination with acids; the tincture is then to be concentrated, and mixed with solution of potash; this sets free the nicotina, which is again taken up on agitation with ether.

The alkaloid may be purified thus:—Oxalic acid is to be added to the etherial solution; oxalate of nicotina falls to the bottom of the vessel: this precipitate is to be repeatedly shaken up with ether, the nicotina being separated as before by potash and ether. With a view to its still more complete purification the etherial solution is to be distilled in a salt-water bath, transferred to a retort through which a current of dry hydrogen gas is made to circulate, exposed in an oil-bath to a temperature of 284° Fahr., to get completely rid of the water, ether, and ammonia; lastly, the temperature is to be raised to 356° Fahr., at which the nicotina distils over drop by drop. It is stated that from twenty-eight pounds of Virginia tobacco at least four per cent. of the alkaloid can be obtained by this process.

Nicotina is a colourless liquid alkaloid, with an offensive odour, and an acrid burning taste. It boils and undergoes decomposition at 482°; it becomes brown by exposure to the air, and is readily combustible with the aid of a wick. It is soluble in water, ether, alcohol, and the oils both fixed and volatile; with the acids it forms salts, which are for the most part crystallisable. A solution of nicotina with one of bichloride of mercury gives a white, flocculent precipitate, a double chloride of nicotine and mercury, and a yellow granular precipitate with chloride of platinum.

Schloesing* has given the following process for estimating the amount of nicotina in dried tobacco. Two drachms of tobacco are to be exhausted by ammoniacal ether in a continuous distillatory apparatus, the ammoniacal gas is to be expelled from the nicotina solution by boiling, and after the evaporation of the ether, the amount of nicotina is to be estimated by the quantity of diluted sulphuric acid, of known strength, required to neutralise it.

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* Chemical Gazette, vol. v. p. 41.

The following are the amounts of nicotina estimated by this process found in different kinds of tobacco.

100 Parts of Tobacco dried at 212°.	Nicotina.
Virgina	6·87
Kentucky	6·09
Maryland	2·29
Havannah (Cigares primera) less than	2·00
Lot	7·96
Lot-et-Garonne	7·34
Nord	6·58
Ile-et-Vilaine	6·29
Pas de Calais	4·94
Alsace	3·21
Tobacco in powder	2·04

Pure nicotina is an energetic poison almost as active as hydrocyanic acid. It was employed by Count Bocarmé for the murder of his brother-in-law; and his trial at Mons a few years since created a great sensation in the public mind.

Nicotianin, *the concrete volatile oil of tobacco*, *tobacco camphor*, is obtained by distillation. Six pounds of leaves yield only about eleven grains of the oil; it has the odour of tobacco, and a bitter taste; it excites in the tongue and throat a sensation similar to that caused by tobacco smoke; applied to the nose it causes sneezing. Hermbstädt swallowed a grain of it, which produced nausea, giddiness, and inclination to vomit.

Since it is chiefly from Tobacco smoke that we must draw our conclusions as to the effect of tobacco smoking on the system, a knowledge of its composition is of great importance. It has been analysed by several different experimenters.

The constituents of *Tobacco smoke*, according to Raab[*], are—

Carbonate of ammonia.
Acetate of ammonia.
Nicotianin.
Empyreumatic oil.
Carbonaceous matter.
Moisture, and several gases.

Unverdorben[†] obtained, by the dry distillation of tobacco, the following products:—

A volatile oil.
An oleaginous acid.
An empyreumatic acid.
Resin.
Traces of a powder insoluble in potash and acids.

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[*] Zenker and Schenk. Naturgesch. d. vorzüg. Handelspfl. Bd. ii. S. 75.

[†] Poggendorff's Annalen, viii. 399.

Odorin, a small quanity.
A base soluble in water (Nicotin ?).
Fuscin.
Red matter soluble in acids.
Two extractive matters, one forming a soluble
the other an insoluble compound with lime.

More recently Zeise* has made a careful analysis of tobacco smoke, and gives the following as its constituents:—

A peculiar empyreumatic oil.
Butyric acid.
Carbonic acid.
Ammonia.
Paraffine.
Empyreumatic resin.
Water.
Acetic acid, probably.
Carbonic oxide.
Carburetted hydrogen.

Lastly, Melsens† has detected nicotina in tobacco smoke. The empyreumatic oil of tobacco is undistinguishable from that of foxglove. It is evident, therefore, that tobacco smoke contains the more active constituents of tobacco, and that it consequently possesses to some extent the properties of the leaf. We shall hereafter enter upon the question of the effects upon the system of the habit of smoking tobacco, but we now confine our remarks to the physiological action and effects of tobacco when administered.

The following Tables were drawn up at the author's request by Dr. Letheby from samples of unmanufactured tobacco, furnished him for the purpose, and were published in the "Lancet" for 1853:—

TABLE A.

Showing the general Composition of Six Samples of Leaf Tobacco, as imported.

	Havannah.	Virginia.	Maryland.	Kentucky.	Turkey.	German.
Hygrometric moisture	12·0	11·4	13·4	13·2	12·4	10·8
Extractive soluble in cold water - - - - -	43·2	40·8	60·0	48·4	58·6	49·0
Extractive soluble in boiling water - - - -	4·0	2·6	4·4	2·4	2·0	3·0
Ligneous matter and insoluble salts - - - -	40·8	45·2	22·2	36·0	27·0	37·2
	100·0	100·0	100·0	100·0	100·0	100·0

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* Annal d. Chemie u. Pharm., vol. xlvii. p. 212., 1843.
† Ann. de Chim. et de Physiq., 3me sér. t. ix. p. 465.

TABLE B.

Showing the general Composition of the Extractive taken up by Ammoniacal Ether.

	Havannah.	Virginia.	Maryland.	Kentucky.	Turkey.	German.
Hygrometric moisture - -	12·0	11·4	13·4	13·2	12·4	10·8
Chlorophyle and fat - -	5·7	2·2	2·7	1·1	2·0	3·6
Nicotine - - - - -	1·5	3·2	2·1	2·7	1·2	2·0
Total (per cent.) soluble in ether	19·2	16·8	18·2	17·0	15·6	16·4

TABLE C.

Showing the Composition of the Cold and Hot Aqueous Extractive.

	Havannah.	Virginia.	Maryland.	Kentucky.	Turkey.	German.
Sugar - - - - - -	0·1	0·03	0·4	traces	3·6	none
Gum - - - - - -	7·6	8·82	10·1	7·6	7·4	7·8
Acids, chiefly malic, with little colouring matter -	4·4	6·58	11·9	3·4	3·4	2·2
Starch - - - - - -	4·0	2·60	4·4	2·4	2·0	3·0
Colouring matter, &c. - -	31·1	25·37	37·6	37·4	44·2	39·0
	47·2	43·40	64·4	50·8	60·6	52·0

TABLE D.

Showing the Composition of the Ash in 100 *Parts.*

	Havannah.	Virginia.	Maryland.	Kentucky.	Turkey.	German.
Carbonate of potash - -	0·5	2·0	4·9	4·25	3·0	4·1
Chloride of potassium, and a little soda - - -	3·0	0·6	0·4	0·25	0·1	0·6
Sulphate of potash - -	2·7	2·0	1·1	1·50	0·9	1·3
Carbonate of lime - -	7·4	5·2	5·8	4·40	3·0	7·0
Carbonate of magnesia -	2·9	2·5	2·6	1·60	1·0	3·3
Phosphate of lime - -	1·6	1·9	2·1	2·40	1·8	2·9
Phosphate of iron and alumina	traces	traces	traces	traces	traces	traces
Silica, chiefly sand - -	0·5	7·4	2·3	0·60	0·8	3·4
Per cent. amount of ash -	18·6	21·6	19·2	15·00	10·6	22·6

Table E.

Showing the Composition of the Tobacco Stalk in 100 *Parts.*

	Havannah.	Virginia.
Carbonate of potash	5·2	4·9
Chloride of potassium	0·5	1·5
Sulphate of potash	0·6	0·8
Earthy carbonates	7·0	8·4
Alkaline phosphates	2·6	2·3
Earthy ditto	2·1	1·4
Iron and alumina	traces	traces
Silica	0·8	0·4
Per cent. of ash	18·8	19·7

It is evident, from the preceding analyses, that the composition of tobacco is subject to very great variations; reviewing these analyses, we find the variations to extend — first to all organic products and compounds, as the gum, sugar, starch, chlorophyle, fat, the organic acids, nicotine, and colouring matter; and secondly, to all the inorganic substances and salts, including a variety of soluble and insoluble carbonates, sulphates, chlorides, and phosphates.

It will be observed that the ash furnished by the tobacco leaf is very great, amounting frequently to considerably over twenty per cent. This character has led to the supposition that it is possible to detect the adulteration of tobacco with leaves other than those of the tobacco plant, by means of the quantity of ash furnished on incineration. It is obvious, however, that no certain reliance can be placed upon this test, since the tobacco ash itself varies very greatly in weight, as is shown even by the preceding analyses, in which there is a variation of from 10·06 to 22·6 per cent. (See table on next page.)

We are now in a position to form some idea of the extreme difficulty in determining, in many cases, the question of the adulteration of tobacco. It is also now evident that it is quite possible to adulterate tobacco to a large extent in a particular manner, and with certain substances, without the possibility of detection by any means at present known to science.

Mr. George Phillips has so far analysed tobacco as to ascertain the relative proportions of *extractive* and *woody fibre* obtainable from different varieties of tobacco. In these experiments the extractive was procured in the following manner: —

One hundred grains of tobacco, previously dried, were placed in two pints and a half of distilled water; the temperature of this was raised to 176° Fahr., and maintained at that heat for fifty minutes; at the end of that time the infusion was strained, and the insoluble portion, retained by the strainer or filtering paper, re-dried until it ceased

Table showing the Per-centage of Moisture, Extract, Soluble Insoluble and Total Ash, and Glucose, in Eight Samples of Unmanufactured Tobacco.

No. of Sample.	Name.		Hygrometric Moisture.	Watery Extract.	Soluble Ash.	Insoluble Ash.	Total Ash.	Grape Sugar, or Glucose.	No. of Sample.
1	Virginia	leaf	12·36	51·20	3·80	13·16	16·96	0·08	1
	Ditto	leaf-stalk	16·60	39 85	6·15	17·80	23·95	traces	
2	Kentucky	leaf	14·70	37 96	4·92	13·20	18·12	traces	2
	Ditto	leaf-stalk	14 28	29·40	8·00	15·56	23·56	evident traces	
3	Missouri	leaf	14·00	48·44	3·60	15·36	18·96	0·50	3
	Ditto	leaf-stalk	18·16	39·20	11·44	16·80	28·24	0·60	
4	Columbia	leaf	14·20	27·64	7·16	11·28	18·44	traces	4
	Ditto	leaf-stalk	12·10	23·20	5 60	14 40	20·00	traces	
5	Maryland	leaf	11·76	23·48	3·24	10·36	13 60	traces	5
	Ditto	leaf-stalk	16·00	21·04	10·88	9·60	20·48	none	
6	Havannah	leaf	14·30	30·84	4·52	17·20	21·72	0·30	6
	Ditto	leaf-stalk	11·60	25·56	9·12	13·96	22·08	1·25	
7	German	leaf	11·25	28·00	4·16	17·68	21·84	none	7
	Ditto	leaf-stalk	16·16	33·33	7·80	14·20	22·00	none	
8	Turkey	leaf	22·96	44 80	3·00	10·76	13·76	3 60	8
	Ditto	leaf-stalk	15·75	34·80	11·03	16·87	27·90	4·91	

to lose weight; it was then weighed. The loss sustained showed the quantity of soluble matter or extractive. The results obtained by Mr. Phillips were as follow:—

Per-centage of Extractive and Ligneous Matter in different Kinds of Tobacco.

	Extractive.	Ligneous Matter.
Virginia, Hand	54·	46·
,, ,,	54·	46·
,, Stripped	51·	49·
,, ,,	53·	47·
Kentucky, Hand	50·	50·
,, ,,	44·2	55·8
,, Stripped	45·2	54·8
,, ,,	46·7	53·3
Maryland, Leaf	43·1	56·9
,, ,,	42·3	57·7
Turkey	53·2	46·8
Porto Rico	30·	70·
Columbian	38·5	61·5
,,	39·2	60·8
Virginia, Stalks	51·5	48·5
Kentucky, ,,	35·9	64·1
,, ,,	33·6	66·4

Mr. Phillips states, that he has experimented with between five and six hunrded samples of tobacco, and that he never found any to give a higher amount of extractive than fifty-five per cent.; also that he found it made no difference whether he experimented with the leaf, or with the cut and manufactured tobacco.

The only other analyses of tobacco which have been made, and which are at all calculated to be of service in determining the question of the adulteration of tobacco, are the following, by Messrs. Brande and Cooper, made in 1845.*

Tobaccos, dried at 212°.	Per Cent. of Extract, &c., soluble in Water.	Per Cent. of Woody Fibre, &c., insoluble in Water.	Per Cent. of Ash after treating with Carbonate of Ammonia.	Per Cent. of Matter soluble in Water in the Ash.	Per Cent. of Matter soluble in Hydrochloric Acid in the Ash.	Per Cent. of Insoluble Matter, as Silica, &c., in the Ash.	Per Cent. of Alcohol obtained from fermented Infusion.	Per Cent. of Saccharine Matter deduced from the obtained Alcohol.
1. Light Missouri, leaf and stalk	49·	54·9	20·97 white	2·17	11·73	5·9		
2. Light Missouri, leaf only	50·	47·7	19·7 white	1·77	12·83	5·1	0·75	1·50
3. Dark Missouri, leaf and stalk	50·	52·4	16·47 white	4·2	10·14	2·13		
4. Dark Missouri, leaf only	51·	50·6	13·8 white	2·17	8·73	2·9	0·35	0·71
5. Light Virginia, leaf and stalk	51·5	53·1	16·4 gray-white	2·53	8·54	5·33		
6. Light Virginia, leaf only	54·	46·1	11·97 green-gray	2·0	0·86	3·11	1·045	2·09
7. Dark Virginia, leaf and stalk	48·5	51·8	14·7 gray	4·8	8·40	1·5		
8. Dark Virginia, leaf only	52·	49·8	12·53 gray	2·63	8·20	1·7	1·46	2·93

1. The samples were dried, and the extract and woody fibre were also dried at 212°. The watery infusions of all contained ammoniacal salts. The salts from the ash, which were soluble in water, consisted of sulphates, carbonates, phosphates, and chlorides, the bases being potassa and lime. The solution by hydrochloric acid contained lime, alumina, phosphate of lime, and oxide of iron.
3. Contained oxide of manganese in small quantity. Sulphates in watery solution of ash abundant. Hydrochloric solution contained an abundance of lime.
4. A trace of manganese; a trace only of phosphoric acid in watery solution.
5. Contained abundance of oxide of manganese.
6. Abundance of oxide of manganese.
7. A mere trace of oxide of manganese, and a trace of oxide of iron; only a trace of alumina.
8. A trace of oxide of manganese; quantity of oxide of iron very great; only a trace of alumina.

Properties of Tobacco.

In small doses tobacco produces a sensation of heat in the throat, and sometimes a feeling of warmth in the stomach; it also frequently excites nausea, and a peculiar sensation of giddiness, more allied to incipient intoxication; by repetition, it acts as a diuretic and laxative.

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* Brande's Manual of Chemistry, p. 1623., 1848.

In larger doses it occasions distressing nausea, accompanied with a sensation of sinking at the pit of the stomach, vomiting and purging; occasionally it acts as an anodyne, or more rarely promotes sleep. But the most remarkable symptoms produced by it are languor, feebleness, and relaxation of the muscles, trembling of the limbs, great anxiety, and tendency to faint; the pulse is small and weak; respiration somewhat laborious; surface cold and clammy, and, in extreme cases, there are convulsive movements.

In large doses the effects are nearly the same, but more violent in degree; the convulsive movements are followed by paralysis and a kind of torpor terminating in death.

The application of tobacco *to abraded surfaces* is a very dangerous practice. A case has been related which proved fatal in three hours and a half, in which the expressed juice had been applied for the cure of ringworm to the head of a child eight years of age.

Tobacco has also frequently proved fatal in the form of a *glyster*. Dr. Copland saw half a drachm in infusion prove fatal.

The operation of tobacco resembles somewhat that of Lobelia inflata, both being anodyne and antispasmodic. In its enfeebling action on the heart it agrees with digitalis, but it is not equal to foxglove in this respect. In its power of causing relaxation of the muscular system it greatly surpasses digitalis. From belladonna stramonium, and hyoscyamus, it is distinguished by causing contraction of the pupil, both when applied to the eye, and when taken internally in poisonous doses, and also by the absence of delirium and of any affection of the throat. From aconite it is distinguished by not possessing the power of paralysing the sentient nerves.

ON THE ADULTERATIONS OF TOBACCO.

We have enumerated the different species from which the several varieties of tobacco are obtained, described the cultivation of the tobacco plant in Virginia, given the minute structure of the leaves, their chemical composition and properties, the processes by which raw or unmanufactured is converted into manufactured tobacco, and, lastly, we have described the different varieties of cut and roll tobacco; these particulars were necessary in order that the subject of the adulteration of tobacco might be the more easily and fully comprehended.

The following are the principal substances which have either been discovered, or have been stated on good authority to have been employed, in the adulteration of tobacco, principally in the form of cut or roll tobacco. They may be divided—

First, into *vegetable substances not tobacco*, as the leaves of the dock, rhubarb, coltsfoot, cabbage, potato, chicory, endive, elm and oak, &c.; malt cummings—that is, the roots of germinating malt; peat, which consists chiefly of decayed moss; seaweed, roasted chicory root, wheat, oatmeal, bran, catechu or terra japonica, oakum, and logwood dye.

Secondly, into *saccharine substances*, as cane sugar, treacle, honey, liquorice, beet root dregs.

Thirdly, into *salts and earths*, as nitre, common salt, sal ammoniac, or hydrochlorate of ammonia, nitrate of ammonia, carbonate of ammonia, the alkalies, as potash, soda, and lime; sulphate of magnesia, sulphate of soda or glauber salts, yellow ochre, umber, fuller's earth, Venetian red, sand, sulphate of iron.

The following has been the experience of the Excise in regard to the adulteration of tobacco as stated in the evidence of Mr. George Phillips, given before the Committee on Adulteration:—

"With regard to tobacco, we have found in *cut* tobacco, sugar, liquorice, gum catechu, salt, saltpetre, and various nitrates; yellow ochre, Epsom salts, glauber salts, green copperas, red sandstone, wheat, oatmeal, malt combings, chicory, and the following leaves: coltsfoot, rhubarb, chicory, endive, oak, elm, and in fancy tobacco I once found lavender and a wort called magwort. It is a fragrant herb, suggestive rather of the nutmeg. In roll tobacco we have found rhubarb leaves, endive and dock leaves, sugar, liquorice, and a dye made of logwood and sulphate of iron."

The adulterations of tobacco most frequently practised are with *water*, *saccharine matter*, as *treacle* and *sugar*, and *salts* of various kinds.

Since tobacco contains all these substances, and since their amount is subject to considerable variation, it is only when they are present in considerable excess that we are enabled to state that they constitute adulterations, unless indeed the original leaf tobacco can be procured to serve as a standard of comparison.

Results of the Examination of Fifty-six Samples of Unmanufactured and Manufactured Tobacco.

From the examination of *Eight* samples of *unmanufactured* tobacco it appeared that—

The hygrometric moisture varied from 11·25 to 22·96 per cent.
The extract, from 23·20 to 51·20.
The soluble ash, from 3·00 to 11·44.
The insoluble ash, from 9·60 to 17·80.
The total ash, from 13·60 to 27·90.
The sugar, from traces to 4·91.

From that of *Forty-eight* samples of *manufactured tobaccos* it appeared that—

The hygrometric moisture varied from 9·80 to 65·76.
The extract, from 29·32 to 62·20.
The soluble ash, from 3·24 to 7·60.
The insoluble ash, from 9·20 to 16·24.
The total ash, from 14·68 to 20·80.
The sugar, from traces to 3·82.

That in the *Bird's-Eye Tobaccos* the soluble ash was very high, in consequence of the large quantity of mid-ribs which these tobaccos contain.

That the extract from the *Negroheads and Twists* was in some cases unusually high, as was also the quantity of glucose; these large extracts were probably, in part, due to the oil employed in the manufacture of these kinds of tobacco, but principally to the use of some saccharine solution.

That not one of the *Forty Samples* of manufactured cut tobacco was adulterated with any foreign leaf, or with any insoluble or organic extraneous substance of any description other than with sugar or some other saccharine matter, which was present in several insances.

The more common adulterations of tobacco consist in the addition of water, sugar, and salts. The presence of these, in amount sufficient to constitute adulteration, can only be declared with certainty, however, when they are in considerable excess, or by a comparison of the unmanufactured and manufactured leaf.

These results are very different from those which might have been anticipated, taking into consideration the notions which prevail generally amongst the public with respect to the adulteration of tobacco, and also the high duty to which this article is subject. The absence of the grosser adulterations is to be explained, we apprehend, by the constant supervision exercised over the manufacture of tobacco on the part of the Excise.

Although, taking a limited number of samples of tobacco, we do not find adulteration to be by any means so common as we anticipated, yet we must not conclude from this that tobacco is never adulterated with foreign leaves and other solid and insoluble substances. The Excise returns show that it occasionally is so, the officers of Excise making from time to time, in the warehouses, &c., of tobacco manufacturers, seizures of dock, rhubarb, coltsfoot, and other leaves, as well as a variety of other vegetable and mineral substances.

On the Detection of the Adulterations of Tobacco.

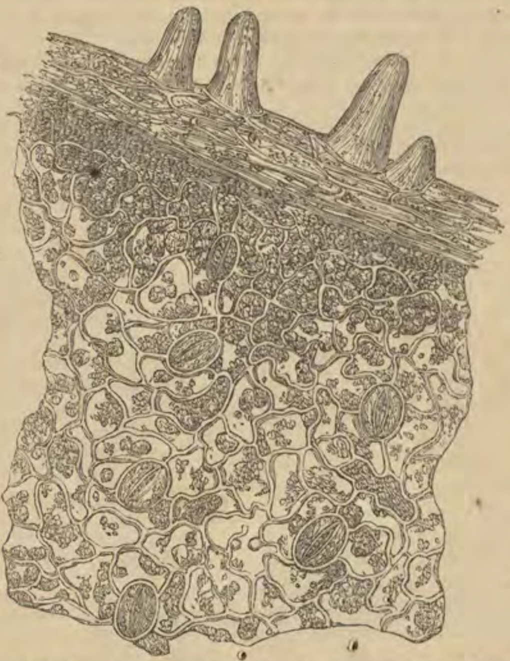
The examination of a sample of tobacco, with a view to determine whether it is genuine or adulterated, is of two kinds—the one *microscopical*, the other *chemical.*

Each sample must be examined with the microscope in order to ascertain whether any foreign vegetable substance is present. If it contain any of those enumerated on the preceding page, in ever so fine a state of powder, and even in the smallest quantities, they may be detected with the greatest certainty with the aid of the microscope, since they all present peculiarities of structure by which they may be readily distinguished.

Structure of Leaves of Dock.—Thus the structure of the leaves of he common dock is very characteristic; it is as follows:—The cells of the lamina do not differ materially in size or shape from those of the tobacco leaf, neither do the stomata present any great peculiarity; like those of tobacco, they occur on both surfaces of the leaves, but of course are most numerous on the under surface; unlike tobacco, however, the cellular part of the lamina is wholly destitute of hairs. *Fig*. 190.

Fig. 190.

PORTION OF UNDER SURFACE OF THE LEAF OF THE DOCK.



Showing the cells and stomata, as also the junction of the cellular part of the leaf with one of the smaller veins. Magnified 220 diameters.

The structure of the mid-rib and veins is very different from that of tobacco; they differ in shape, in the form and nature of the spines or hairs which arise from them, and in the arrangement of the vessels and woody fibre. Transverse sections of the mid-rib are of a somewhat triangular form, the base of the triangle being smaller than the sides; one of these, viewed with an inch object glass, presents six prominences, indicating the number of ridges by which the mid-rib, in a longitudinal view, is seen to be traversed; of these ridges, one is situated on the upper surface of the mid-rib (the base of the triangle), between the origins of the lamina of the leaf; the other five are below, one in the centre large and prominent, forming the lower surface of the mid-rib (apex of the triangle), and two on either side.

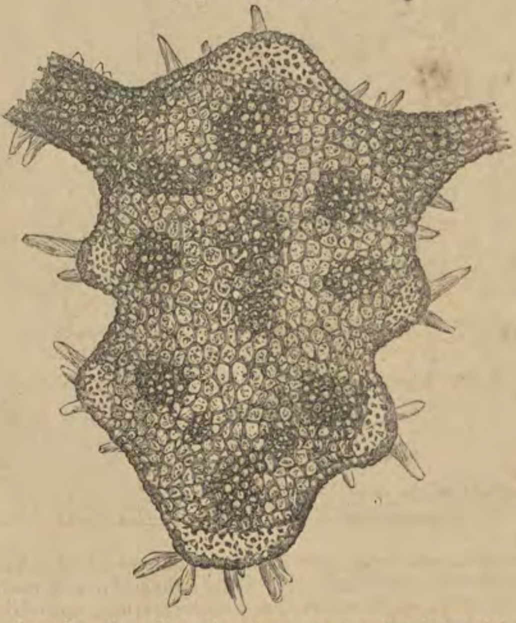
The hairs, or rather spines, spring from the surface of the mid-ribs and veins, and principally from the ridges; they are thick, short, hollow, striated, of considerable diameter, and terminate in obtuse rounded extremities; it is these spines which impart a feeling of roughess to the finger passed along the mid-rib.

The woody fibre and vessels traverse the mid-rib in bundles; the number of bundles being greatest in sections of the larger mid-ribs:

Fig. 191.

Transverse Section of Mid-rib of Leaf of Dock.

(Magnified 40 diameters.)



in those of small and medium size there are usually six or eight fasciculi. *Fig.* 191.

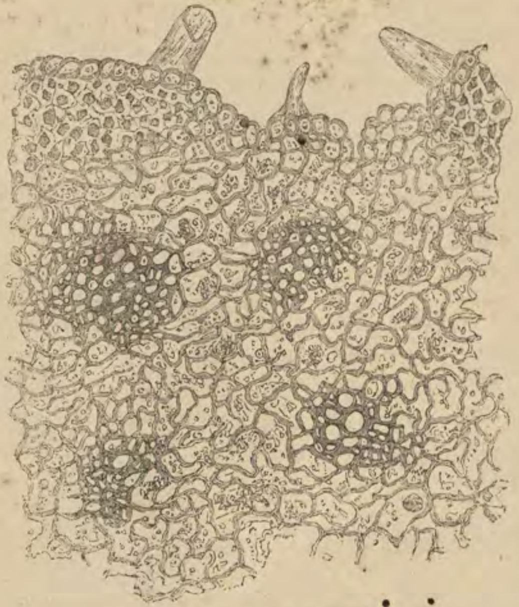
The cells forming the ridges are very characteristic, being small and angular; those composing the internal part of the mid-rib, and which are traversed by the vascular and woody tissue, are larger and more reticular.

The above structural peculiarities are clearly shown in *figs*. 192, 193.

Fig. 192.

PORTION OF TRANSVERSE SECTION OF MID-RIB OF LEAF OF DOCK.

(Magnified 90 diameters.)



Structure of Leaf of Rhubarb.

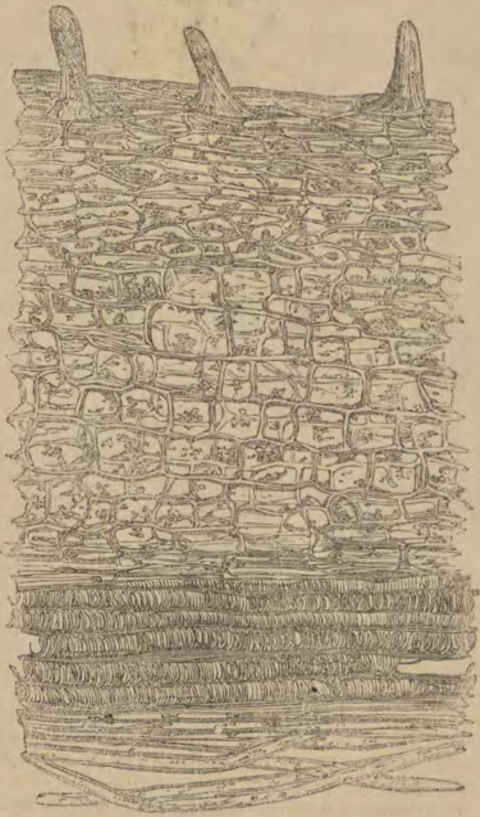
The structure of the dock leaf being so very distinct, we will now show that the organisation of the rhubarb leaf is equally characteristic.

In the stomata, and in the form and size of the cells of the rhubarb leaf, slight differences only are observable; but the walls of the cells are finely striated, as shown in the wood-engraving; and this is a character by which rhubarb leaf may be at once known from tobacco. Other differences are found in the characters of the short spines or hairs which clothe the leaf, in the form of the mid-rib and veins, and in the presence of gland-like bodies scattered throughout the lamina of the leaf.

Fig. 193.

LONGITUDINAL SECTION OF MID-RIB OF LEAF OF DOCK.

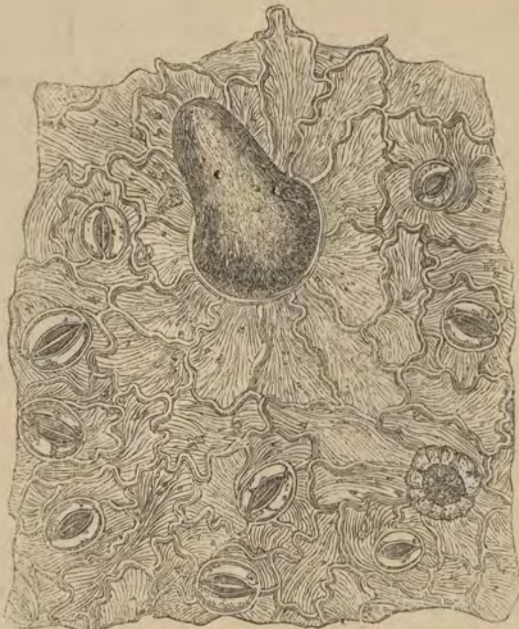
(Magnified 90 diameters.)



The hairs or spines are short, thick, hollow, striated, and terminate in obtuse, rounded extremities. They resemble closely in form those of the dock, but differ in being several times larger; in the character and fineness of the striæ with which they are marked, and by their distribution; for while in the dock the spines spring only from the mid-rib and veins, in the rhubarb leaf they arise from all parts of the leaf, the lamina as well as the mid-rib and veins.

Fig. 194.

PORTION OF UNDER SURFACE OF RHUBARB LEAF.



Showing the situation of the cells, one of the short spines or hairs, and also one of the gland-like bodies. Magnified 220 diameters.

The mid-rib and veins, as in dock, consist on the outside of small, angular cells, succeeded by large, reticular cells, which are traversed by bundles of woody fibre and spiral vessels; the differences between the mid-ribs of the leaves of the two plants being in form, and in the absence of distinct ridges on the mid-rib of the rhubarb leaf. *Fig.* 194.

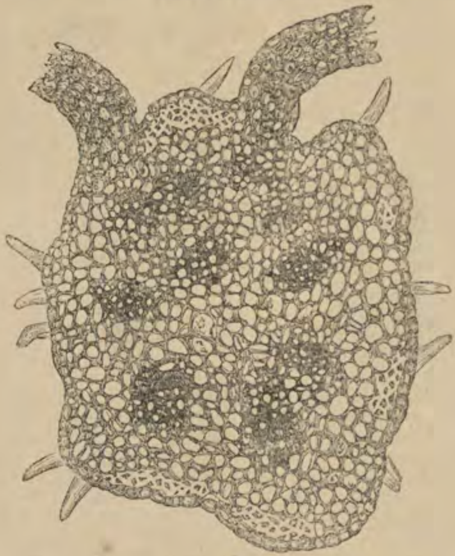
Structure of the Leaf of Coltsfoot.

We now proceed to describe the minute organisation of the Coltsfoot or Tussilage leaf, which has been stated to have been sometimes employed in the adulteration of tobacco.

Fig. 195.

TRANSVERSE SECTION OF MID-RIB OF RHUBARB LEAF.

(Magnified 40 diameters.)

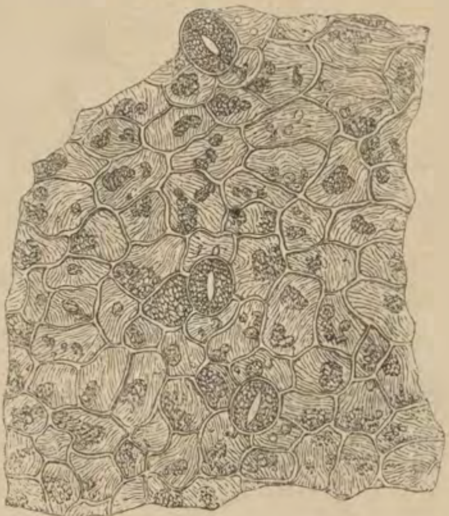


The cells which form the upper surface of the leaf of coltsfoot are of small size, angular, and faintly striated; there are but a few stomata, and no hairs, except on the mid-ribs and principal veins. *Fig.* 196.

The structure of the under surface of the leaf differs entirely from that of the upper. The cells are also of small size, but their margins are waved, and the walls are not striated; the stomata are exceedingly numerous, and the whole of this surface is clothed with delicate filamentous hairs, which impart the downy character to the leaf; intermixed with these are other hairs of much larger size, and which, being jointed, bear some resemblance to those of tobacco, but they want the distinct glandular terminations. *Fig.* 197.

Transverse sections of the leaf-stalk present the following structure:—Externally, there is a well-defined border of distinctly angular cells; from the outside of these spring the two kinds of hairs described above. The central portion of the section is made up of loose cellular tissue similar to that of the mid-ribs of many other leaves, and it is traversed by from about six to eight bundles of woody and vascular tissue, the number usually varying with the size. The large *leaf-stalks* of the coltsfoot would hardly, however, be used in any case for the adulteration of cut tobacco.

Fig. 196.
PORTION OF UPPER SURFACE OF LEAF OF COLTSFOOT.
(Magnified 220 diameters.)



Sections of the *veins* present a nearly similar conformation; the principal difference is in the number of the bundles which traverse them, there being almost invariably but three such bundles. By this character the veins of the leaf of coltsfoot are at once distinguished from those of the other leaves we have described. *Fig.* 198.

Differences equally marked characterise the other vegetable substances which have been actually detected entering into the adulteration of tobacco. Descriptions and representations of the majority of these will be given at some future period.

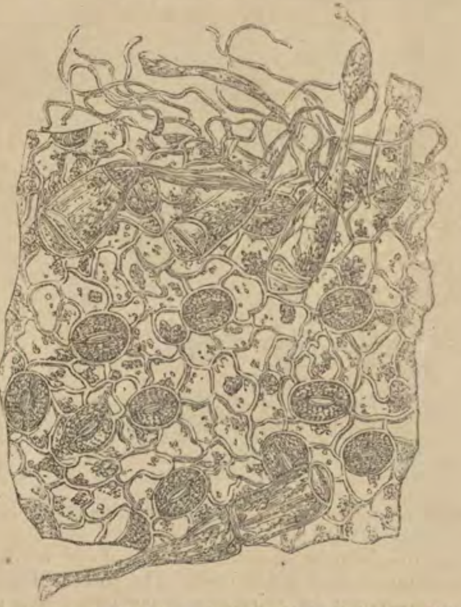
We will now proceed to describe the processes to be pursued in the *chemical* examination or analysis of tobacco.

The particulars to be ascertained are the per centage of water, of extractive, of sugar, of ash, together with, to some extent, its composition.

One hundred grains of each of the tobaccos are to be treated as follows: — They are to be dried for twenty-four hours in a water-

Fig. 197.

PORTION OF UNDER SURFACE OF LEAF OF COLTSFOOT,



Showing the numerous stomata, as also the two kinds of hairs with which this surface of the leaf is invested.

bath, and then re-weighed; the loss shows the amount of *hygrometric moisture* which the samples contained.

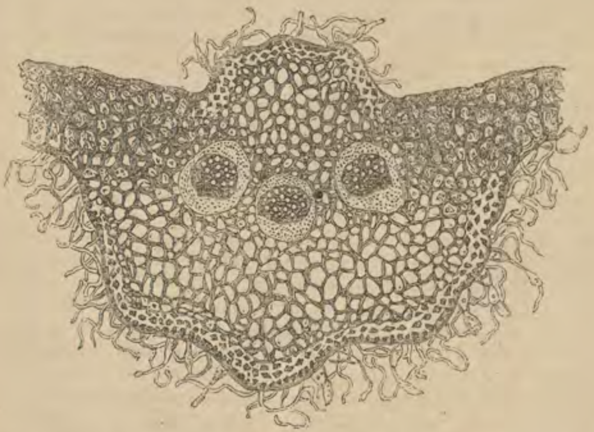
They are then to be macerated for twenty-four hours in cold, distilled water, by which means the extractive is obtained. They are next boiled for an hour. The residue is *ligneous matter*, yielding from three to ten per cent. of ash, composed chiefly of silica, with earthy carbonates and phosphates. The table marked A, p. 585., represents the results obtained from the genuine tobacco leaf by the above processes.

One hundred grains of each tobacco are next to be submitted (according to the process of M. Schloesing) to the action of ammoniated ether; the ether distilled off, and the residue neutralised with dilute sulphuric acid of known saturating power; by this means the proportions of *nicotine*, *chlorophyle*, and *fat* are determined. The table marked B, p. 586., represents the results obtained by this process. In ordinary cases this part of the analysis may be omitted.

Fig. 198.

TRANSVERSE SECTION OF ONE OF THE VEINS OF LEAF OF COLTSFOOT.

(Magnified 40 diameters.)



The extractive obtained by the first operation is to be treated as follows :—

It is to be dissolved in distilled water, and the solution treated with basic acetate of lead and filtered. The filtered liquid and the precipitate decomposed by sulphuretted hydrogen, and evaporated to dryness, one is treated with a modification of Trommer's or the copper test for sugar, and the other with dilute alcohol for malic acid and gum. The table marked C. represents the results obtained by the above process.

If it be suspected that cane sugar is present, instead of adopting Fehling's process we must employ the fermentation test, and estimate either the quantity of carbonic acid gas evolved, or the amount of alcohol generated; indeed it saves time to employ the fermentation test in nearly all cases for the determination of the presence of saccharine matter, whether in the form of glucose or cane-sugar.

The fermentation test is used in the following manner: — 1000 grains of tobacco are to be placed in a vessel, and a pint or so of water, at a temperature of about 100° Fahr., poured upon it; the infusion is then to be strained, and 250 grains of dried yeast added; the mixture is next to be set aside for forty-eight hours to ferment, at a temperature of about 60°; lastly, the liquor must be introduced into a retort, the alcohol distilled over, and its amount estimated, or the carbonic acid may be collected, and the amount of sugar calculated therefrom.

The method of calculating the sugar from the amount of carbonic acid formed during fermentation, will be found detailed at some length in Bowman's "Medical Chemistry," p. 93.

For the determination of the salts contained in tobacco one or two hundred grains should be incinerated, and the ash tested for the chief acids and bases — the sulphuric acid, chlorine, lime, soda. It is well to dissolve out the soluble from the insoluble portion of the ash, and to test these separately.

Hydrochlorate of ammonia and the nitrates must be sought for in a cold infusion of tobacco, as the first is entirely dissipated on incineration of the ash, and the latter are decomposed.

The presence of an ammoniacal salt is sufficiently indicated on the addition of a little caustic potash to the solution, the ammonia being evolved.

The following process may be pursued for the detection of the nitrates.

One of the best methods of detecting the presence of nitrates is to add to a concentrated infusion of the aqueous extract a few drops of sulphuric acid, and then a crystal of sulphate of protoxide of iron: a dark brown discoloration immediately occurs around the crystals if any nitrate be present. This generally disappears upon simple agitation of the fluid, and invariably upon the application of heat.

For the quantitative estimation of nitric acid consult Fresenius' "Quantitative Analysis," p. 274.

The processes for the detection of iron, silica, or sand, and chromate of lead have already been described; that for the latter substance under the head of Coloured Sugar Confectionery.

The amount of extract obtained from any tobacco varies somewhat even in different portions of the same leaf treated in precisely the same manner, but when different methods of extraction are followed the results differ still more considerably; the quantity of distilled water used, the temperature to which it is raised, and the length of time during which the infusion is kept hot and maceration allowed to continue, will affect the results; when therefore we are desirous of obtaining comparative results, the same method of extraction should in all cases be carefully pursued.

With regard to the method of proceeding for the detection of grape sugar or glucose in tobacco, we would remark that we find it necessary to add a considerable excess of Fehling's test liquor, in order to precipitate all the sugar, and hence the quantity of glucose present cannot be accurately determined by the amount of test liquor used. One of the best modes of proceeding for the quantitative determination of glucose is as follows: —

Take a solution of the extract of 100 grains of tobacco and strain it through muslin; precipitate with a slight excess of basic acetate of lead, and filter; pass sulphuretted hydrogen through the filtered liquid. re-filter, and evaporate nearly to dryness; dissolve the residue in about one ounce of liquor potassæ, dilute with one ounce of distilled water, and filter again to remove the salts of lime; then add half an ounce of Fehling's solution; put the mixture into a large test tube or flask, boil for a few minutes, and observe whether any yellow streaks of reduced oxide of copper make their appearance. Should that be the case, set the solution aside at rest for two hours, and collect the precipitate; weigh and calculate the quantity of glucose to which it is equivalent. One grain of the red oxide of copper is nearly equal to half a grain of grape sugar or glucose.

The following is a more simple method, and in the case of tobacco affords results which are for the most part sufficiently accurate. Take 1000 grains a of solution of tobacco, containing two grains of the dried extract to one ounce of water; add four drachms of liquor potassæ; boil, filter, and then add about 400 grains of Fehling's test liquid, and heat to boiling; if any glucose be present, the red oxide of copper will be thrown down; collect and thoroughly wash the precipitate in order to free it from any albumen that may be present; weigh and calculate as before.

CIGARS, AND THEIR ADULTERATIONS.

The second form in which manufactured tobacco is consumed is that in which the leaves are rolled up into cigars and cheroots. The use of tobacco in this form has been rapidly advancing within the last few years, the cheaper penny cigars taking the place, to a great extent, of cut tobacco, although the consumption of both, from the growing taste of the public for tobacco-smoking, has been for some time, and still is, on the increase.

The process employed for making cigars and cheroots in England is precisely the same as that adopted in other countries. It is as follows:—

The leaves are first slightly moistened with water; they are then "stripped," that is, the mid-ribs are removed in the same manner as described in the description of the manufacture of Cut Tobacco, by which means each leaf is separated into two parts; the half-leaves are next smoothed out by the hand, and put under a slight pressure, to remove any creases which may have occurred in the packing. This first process is generally the work of a woman or boy, who, seated near the cigar-maker, hands up the half-leaves as fast as they are required.

The "cigar-maker" is seated in front of a stout wooden bench, made somewhat like a butler's tray, it being furnished with raised edges on three of its sides, but open on that next the workman. He takes one of the half-leaves, and by means of a very sharp knife cuts it into the form of a section of the rind of an orange; upon this a sufficient quantity of fragments and cuttings of leaf are placed, and the "maker" proceeds to roll them up, and fashion them into the well known form of a cigar or cheroot; over this, again, a long narrow strip of tobacco leaf, of rather a better quality and appearance, termed the "wrapper," is spirally rolled; this is twisted at the smaller end into a kind of knot, to prevent its becoming loosened. The cigar is next placed against a gauge made of iron, and cut from its thick end to the required length. Great dexterity is requisite in the making of cigars, and the work proceeds with the utmost rapidity, a few seconds only being employed in the manufacture of each. After the cigars are removed from the makers' hands, they are placed on open trays in a room artificially heated, in order to thoroughly dry them; they are then weighed, and packed in boxes of various sizes for sale.

Cigars and cheroots are known in the trade by a variety of different names, taken either from the name of the country from whence they are imported, or the kinds of leaf from which they are made, while in other cases the name of the maker or the caprice of the manufacturer determines the name. Thus we have Havannah, St. Lucia, Cuba, and Duch Cigars, and Chinsura and Manilla Cheroots; Columbia and Amersfoort Cigars; Cabana, Silva, and Lopez Cigars, and the innumerable fanciful names that have at various times been given them, as Principes, Fragancias, Panetellas, Kings, Queens, Imperials, and a host of other names, the only distinguishing characters being their size, colour, make, and form. The above names all relate to foreign cigars and cheroots.

British cigars and cheroots are most frequently made in imitation of the most famous and saleable varieties of the above, and take their names from them. It should be mentioned, however, that nearly all the cigars sold as Cubas are of British manufacture. Vast numbers also of cheroots peculiar to the English markets are manufactured here; one sort is termed "Bengal," and are sold usually at 1½*d.* or 2*d.*; the other, "Pickwicks," the price of which is 1*d.* each.

On the Adulterations of Cigars.

Although it is commonly believed and stated that cigars are very generally adulterated, and that they often consist of anything rather than tobacco, we do not find any precise observations recorded respecting the adulterations alleged to be practised.

Results of the Examination of Samples.

Out of *Fifty-eight* samples of cigars and cheroots subjected to examination, *three only were found to be adulterated.*

One of these was purchased of a hawker in Whitechapel Road; the cheroots were made up of twisted wrappers or layers of thin *paper*, tinted of a bistre colour, while the interior consisted entirely of *hay*, not a particle of tobacco entering into their composition.

Another was procured at a review in Hyde Park; the cigars consisted externally of tobacco leaf, but internally they were made of *hay*.

The third sample consisted of penny cigars, and contained internally *apple parings* and other rubbish.

It appears that about the neighbourhood of Whitechapel, the sale of spurious cheroots constitutes a regular business. Men dressed as sailors, and appearing as though they had just returned from a long voyage, are constantly on the look out for young gentlemen who are supposed to have a little money in their pockets, and to be somewhat inexperienced; to such these fellows address the inquiry in a mysterious manner, as though they feared being overheard by the police — "Do you want to buy a box of real Manillas? I have got a few boxes '*on the cross;*' just come with me down this passage, and I will show you them and let you taste them," at the same time handing out a genuine Manilla cheroot, as if taken from the box, for the young gentleman to try, who, being satisfied with the quality and flavour, closes the bargain, and walks off home with a box of brown paper and hay under his arm, congratulating himself on his purchase, and anticipating the pleasure in store for him from smoking his acquisition!

Twelve samples of Manilla cheroots were tested for Opium, but that narcotic was not detected in a single instance.

The adulteration of cigars most frequently practised is to steep the leaves in various saccharine and saline infusions whereby their weight is greatly increased.

It thus appears that cigars and cheroots are subject to but little adulteration; the cheap penny ones even consisting, in the majority of cases, entirely of tobacco, though there is no doubt but that it is tobacco of very inferior quality. This is again quite contrary to what might have been anticipated from the general belief entertained; and it is no doubt due mainly to the great difficulty of finding, or using, any article that could be substituted for the tobacco leaf.

In consequence of the high duty of 9*s*. 6*d*. per pound, cigars, like tobacco, are often smuggled into this country, as is shown by the evidence of several witnesses who were examined before the Select Committee of the House of Commons on the Tobacco Trade, in August, 1844.

Another very common practice is to sell British-made cigars and cheroots as foreign ones; this deception is carried into effect by making, branding, and labelling boxes in exact imitation of the different foreign boxes in which cigars are imported. This practice prevails extensively with English-made Havannah cigars and Manilla cheroots; although in the case of Manilla cheroots the fraud is easily detected, since it is scarcely possible to imitate these cheroots so closely as not to allow of the discrimination between the British and foreign-made article. So generally is this practised, that probably not one third of the cigars sold in boxes are what they profess to be — namely, foreign-made cigars.

There is a kind of cheroot called *Chinsurah;* this was commonly sold in the shops for some years, although it was known that but two or three cases had been entered at the Custom House, and paid duty, during the whole time. In one year alone, twenty thousand pounds weight of these cheroots found their way into the market, in addition to from eighteen thousand to twenty thousand pounds of Manilla cheroots, without having paid duty.

The cheroots known as *Bengal*, notwithstanding their East Indian name, are all British-made, having originally been prepared in imitation of Chinsurah cheroots. Thus we see, what with smuggling and the passing off inferior English-made cigars as foreign, by the imitation of the form, manufacture, branding, and labelling the boxes, &c., there still remains a wide scope for fraud and adulteration in the articles of cigars and cheroots.

On the Detections of the Adulterations of Cigars.

The cigars and cheroots are to be examined in the following manner: — Very thin transverse sections are to be made from different parts of the whole cigar, so as to include all its contents; these are to be afterwards examined under the microscope with an object-glass of one inch focus, and the second eye-piece; each cigar is then unrolled carefully, and every leaf or fragment of leaf also subjected to microscopic examination. In this way but little difficulty is experienced in determining whether the cigar consists of tobacco or not, the structure of the leaf, and especially of the glandular hairs, being so peculiar as to allow of ready identification.

In addition to microscopic examination, the cigars should be examined chemically for sugar, and the ash for extraneous saline substance; while Manilla cheroots, which are commonly reported to contain opium, are to be subjected to analysis with a view to the discovery of the presence of that drug.

The process to be adopted for the detection of opium is as follows: —

Four cheroots from each sample are to be cut up and infused for twelve hours in about ten ounces of cold water, slightly acidified by the addition of a few drops of acetic acid. The liquid is then filtered off, and partially precipitated with basic acetate of lead, by which means a considerable proportion of colouring matter is thrown down. The solution is next refiltered, treated with three drachms of animal charcoal, and allowed to digest for twenty-four hours, frequently agitating it; by this means it becomes further decolorised, and loses its bitter taste. The charcoal is then collected on a filter, and boiled with two portions of rectified spirit, each of about the same bulk as the liquid originally employed. The spirit, which has acquired a slight greenish-yellow tint, is submitted to distillation, so that it should not be wasted, and it leaves behind an extract of a yellowish colour, having a bitter taste; this is purified by washing on a filter with weak liquor ammoniæ, then with ether, and lastly, with rectified spirit; this is now evaporated, and the residue treated on a white porcelain plate, with a little peroxide of manganese, and a drop of concentrated sulphuric acid; and if morphia is present, even in only very small quantity, the residue will assume a rich violet tint, similar to that which occurs with strychnia when treated in a similar way.

It does not appear, after a most careful analysis of numerous samples according to the process above given, and notwithstanding the generally received opinion, that Manilla cheroots usually contain opium. The difficulties attending an organic analysis of this kind are very great, but the results obtained appear to be of a character to be relied upon, since, by the process above given, so little as one quarter of a grain of crude opium may be satisfactorily detected in a single cheroot to which that drug has been purposely added.

SNUFF, AND ITS ADULTERATIONS.

The third and last form in which the tobacco leaf is employed is in the state of a more or less finely-reduced powder, constituting snuff.

Snuff is made principally from the stalks or "*strippings*" of the leaf which are rejected in the processes of manufacturing cut tobacco and cigars; some snuffs, however, contain a proportion of leaf as well as stalk.

Snuff is met with in commerce in two states—namely, the dry and the moist. Of each of these there are several varieties, the characters which distinguish them depending, in most cases, upon differences in the processes of manufacture, in the relative proportion of the stalk and leaf, in the degree of moisture, in the flavour or pungency, and in the scenting.

The dry snuffs are in general much more finely ground than the moist: the different kinds of Scotch, Irish, and Welsh are comprised under this head.

The moist snuffs, of which there are a great many varieties, are known in the trade under the following names:—Brown and Black Rappee, John Bull, Hardham's, 37, Princeza, French and Dutch Carrottee, Masulapatam, Prince's Mixture, Grand Cairo, and a great many others, which derive their names either from the fancy of the maker or the fashion of the day.

Manufacture of Snuff.

In the manufacture of the different varieties of snuff, the process adopted depends upon the kind required to be made. Scotch snuff, which is said to be the purest of all, is made almost entirely from the stalks of tobacco; and this being a dry snuff, as little moisture as possible is added—merely sufficient to prevent the finer particles from escaping and being lost in the act of powdering or grinding, which would otherwise occur. The stalks, cut up into small pieces, are introduced into a kind of iron mortar or "*mull*," as it is termed. This is furnished with a pestle, heavily weighted, the handle of which is connected with a set of jointed arms or levers, so adjusted as to give it a peculiar rotary and grinding motion, this being the best calculated to effect the reduction of the stalks to powder. A series of twenty or thirty, or more, of these mortars or "mulls" are arranged and fixed on a strong oak table, with similar machinery attached to the pestles of each, and all of which are capable of being worked at the same time by means of a steam engine and connecting shafts and wheels. After the snuff has been reduced to the requisite degree of fineness, it is removed from the "mulls," and dried and flavoured according to a process peculiar to the different manufacturers.

Irish and Welsh snuffs are also dry snuffs; but before the stalks are reduced to powder, they are subjected to a roasting process in closed cylinders, which assists in imparting the peculiar smell by which these snuffs are characterised. These two varieties of dry snuff are ground in mills of a similar description to those employed in the powdering of Scotch snuff: lime water, and even powdered lime, frequently enter into the composition both of Welsh and Irish snuff. Indeed the addition of the former is allowed by the Excise laws. The most celebrated of the Irish snuffs is that manufactured by the firm of Lundy Foot and Co., of Dublin, and from which it takes its name.

On account of the high duty, over 6*s*. per pound, to which foreign manufactured snuff is subject, but a very small quantity is ever imported and passed through the Custom House, as it can be made in England quite equal in quality to the foreign, and for less than half the duty charged upon the latter. Indeed, preference is in general given to English-made snuffs.

The different varieties of the rappees or moist snuffs are likewise made chiefly from stalks, but a small proportion of the leaf is also introduced, as well as the finer parts and siftings of cut tobacco called "*smalls*," which are too fine to be conveniently smoked in a pipe.

The process followed in the manufacture of moist snuffs differs somewhat from that just described. The stalks cut into fragments, pieces of leaf, and smalls, are well moistened, and ground in a mill of the following construction:—A pair of very heavy cylindrical stones (in form like the common grindstone), six or eight feet in diameter, and a foot or eighteen inches thick, are set up on edge, parallel to each other, and a few inches apart, on a wooden slab or bed slightly hollowed out. These stones have a twofold motion given to them—a rotary one on their own horizontal axis, and a traversing rotary motion round the surface of the bed, similar to the two wheels of a carriage going round in a small circle; this motion is communicated to them by means of an upright shaft driven by machinery. The ingredients for the snuff are placed upon the bed, and the broad edge of the massive stones passing repeatedly over them, combined with their rotary, grinding motion, soon reduces them to powder. The construction and working of this kind of snuff mill is the same as that used in making gunpowder, or for crushing the apples in the manufacture of cider. After the snuff has been reduced to the required degree of fineness, it is heaped up in a trough, and again moistened thoroughly, or "sauced," as it is termed, and allowed to remain a considerable time, by which means a certain degree of fermentation is induced; it is turned with a shovel from time to time, and re-liquored as the moisture evaporates. The flavour of the snuff depends much upon the extent to which the fermentation is allowed to proceed; this fermentive process also adds greatly to its depth of colour. After the snuff is thus far manufactured, the salts, or alkaline salts, allowed by the Excise regulations, are added. The salt is said to be chiefly employed to ensure the preservation of the snuff from mouldiness, and to cause it to retain its moisture; while the alkaline salts are used to increase its pungency; at the same time they add considerably to the weight of the snuff.

In the scenting of snuffs, the perfumes used—either the essential oil of bergamot, or otto of roses, and in some cases powdered orris root—are added after the snuffs are manufactured. The process adopted is as follows:—The snuff is spread out upon large skins or sheets of parchment, and the oils sprinkled over it from a bottle with slits cut in the cork; the snuff is frequently turned over; and lastly it is rubbed with the hand through a wire sieve. The only snuffs that are ever scented are brown and black rappee, Grand Cairo, and prince's mixture, amongst the moist snuffs, and Scotch amongst the dry snuffs.

The greater part of the snuff consumed in London is ground in snuff mills, situated near Mitcham, in Surrey, in consequence of the facility afforded for working the mills by means of the river Wandle, which runs through the town. There are several of these establishments to which the London manufacturers send their snuff after having undergone a certain stage of preparation. Beyond the preparatory drying and grinding, it is said that nothing further is done to the snuff in the snuff mills; the proprietor not only prepares it before sending it to the mill, but in most cases passes it through some finishing operations after it is brought from the mill. Many of the London manufacturers have, however, small mills in their own establishments for grinding small quantities of snuff, or for passing the various kinds of fancy snuffs through any particular process; but there are very few establishments in London where the main bulk of the snuff is ground.

On the Adulterations of Snuff.

Forty-three samples of snuff were subjected to microscopical and chemical examination and analysis, and from these it appeared that snuff is subject to a very large amount of adulteration.

The principal results arrived at were—

That *common salt* is added in large quantities to all descriptions of snuff.

That *oxide of iron*, derived from different descriptions of coloured ferruginous earths, as *red ochre*, *yellow ochre*, and some of the brown earths, as *umber*, was present in upwards of two thirds of the samples.

That *chromate of lead*, a very poisonous substance, was detected in nine of the samples, amounting in one instance to nearly eight per cent.

That *oxide of lead*, an equally poisonous substance, probably in the form of *red lead*, was discovered in three cases.

That *bichromate of potash*, a still more poisonous substance, was present in three cases.

That many of the samples contained *powdered silica*, probably *powdered glass*.

These as well as some other less important results, stated more in detail, were—

That *chloride of sodium*, or *salt*, is added in large and very variable quantities to all descriptions of snuff, the proportions ranging from 1·0 to as much as 12·8 per cent. Where the amount of chloride is less than 1·0 per cent., it is probable that it is derived from the tobacco itself, as well as the water used to moisten it.

That the *alkaline and earthy carbonates*, chiefly the *carbonates of potash and lime*, are likewise added to snuff, sometimes in considerable quantity, but usually to a less extent than chloride of sodium. One of the samples yielded 3·9 per cent. of carbonate of potash, and another no less than 10·8 per cent. of carbonate of lime. On looking over the table of analyses, it will be seen that the amount of earthy carbonates varies considerably in the different samples, as was the case with the chloride of sodium, the lime being present in somewhat larger proportion in the dry snuffs, as the Scotch, Irish, and Welsh—to these snuffs the law allows the addition of lime water. When at the same time carbonate of potash is added, decomposition takes place, part of the carbonic acid of the carbonate of potash unites with the lime, and so forms carbonate of lime. This renders it difficult to state exactly the relative proportions of lime and potash employed.

It would appear also that in some cases the *alkaline and earthy phosphates* are in excess in snuff, as much as 7 per cent. of the former having been detected in one of the samples, and 4·8 per cent.

of the latter in another. The stalks of tobacco contain a very large and variable quantity of phosphates, especially the alkaline phosphates, and it is probable that they are very rarely added to snuff for the purpose of adulteration.

That the *alkaline sulphates* are likewise slightly in excess, amounting in one sample to 5·4 per cent.; in this case the addition may have been intentional.

That *oxide of iron* derived from different descriptions of coloured ferruginous earth, as *red ochre*, *yellow ochre*, and some of the brown earths, as *umber*, was present in upwards of two thirds of the samples, amounting in one case to no less than five per cent. It is especially to be observed, that while all the Scotch snuffs contained iron, the oxide of that metal was not present in any one of the samples of Welsh and Irish snuffs submitted to analysis. The presence of ferruginous earths, as well as of some other colouring matters, is frequently indicated by the colour of the ash. Genuine tobacco invariably yields an ash which is more or less grey, while the ashes of snuffs containing iron, lead, and some other mineral colouring matters, are always to a greater or less extent coloured; when decidedly so, we may safely declare that some substance has been employed to colour the snuff. In unadulterated tobacco, the iron present amounts only to traces; nearly all therefore of the different kinds of snuff examined, excepting the Welsh and Irish, were adulterated with coloured ferruginous earths, especially the Scotch rappees, and scented rappees, in one of which the iron and alumina amounted to five per cent. *The presence of coloured ferruginous earths in snuff is an adulteration.*

That *chromate of lead* was detected in *nine* of the samples, amounting in one instance to 4·6 per cent. It occurred in five out of the nine samples of Scotch snuff examined, in one of the four samples of Welsh, and in one of the three samples of Irish snuff submitted to analysis. *The presence of this metallic compound in snuff constitutes an adulteration.*

That *oxide of lead*, probably in the form of *red lead*, was discovered in three cases, as much as three per cent. being found in one of the samples of Hardham's 37. *The presence of this metallic oxide is also an adulteration and an infraction of the Tobacco Act.*

That *bichromate of potash* was present in three of the samples; in two of the cases it was found in the Scotch snuff, amounting in one sample to 6·2 per cent. *The presence of this salt likewise constitutes an adulteration.*

That many of the samples contained considerable quantities of *silica*, amounting in one instance to no less than 8·4 per cent. *In some of the samples the addition was unquestionably intentional.* Genuine tobacco rarely contains more than 3·4 per cent., and usually much less. In most of the siliceous residues of the ashes *shining particles* were observed, which under the microscope presented all the appearance of powdered glass; but since earth contains similar particles in large quantities we are not able to state whether in any case powdered glass had been added; to the majority of the samples, however, it was manifest from the weight and appearance of the residues that no such addition had been made. The ashes of the rappees all furnish a siliceous residue, which, after the action of the acids, in its gelatinous character resembles the silica derived from such a silicate as glass.

That *powdered orris root* was detected in two of the samples. *The presence of this in snuff is likewise an adulteration.*

That the *total weight of ash* furnished by the incineration of the greater number of the snuffs examined, although many of them were very moist, much exceeded that of genuine tobacco after being dried. While the ashes of samples *of the latter have been found to vary in weight from* 10·6 *to* 22·6, those of the snuffs which were not dried, and many of which contained very large per-centages of water, were in no case under 18·26 per cent., while in one instance it amounted to 35·54 per cent. Had the snuffs been dried before analysis, as was the tobacco, the difference in the weight of the ashes would have been much more evident. The average proportion of water in the moist snuffs is about 25 per cent.

Cephalic Snuff.

This snuff, on examination, was found to consist almost entirely of tobacco stalks ground to a very fine powder, and disguised by being flavoured or scented with some essential oil or oils, most probably that of lavender. 100 grains furnished 21·6 grains of ash, of a dirty brown colour, which was composed of *chloride of sodium*, 2·0; *alkaline carbonates*, 3·9; *earthy carbonates*, 4·0; *alkaline phosphates*, 5·2; *earthy phosphates*, 2·1; *alkaline sulphates*, 0·9; *oxide of iron and alumina*, 1·9; and *silica*, 1·6 grains.

Grimstone's Eye Snuff.

A prolonged examination of this article by the microscope shows that it is made up of several distinct vegetable substances. Amongst these, after considerable trouble, we have succeeded in identifying the following: *powdered orris root*, *savory*, *rosemary*, and *lavender*. There are probably one or two other vegetable substances, the names of which we have not as yet ascertained; but it does not contain any hellebore, assarabacca, nor tobacco. 100 grains, on being incinerated, afforded 30 grains of ash, of a light reddish-brown colour, composed of *chloride of sodium*, 12·8; *alkaline carbonates*, 3·8; *alkaline phosphates*, 4·6; *earthy phosphates*, 2·8; *alkaline sulphates*, 0·8; and *silica*, 5·2 grains.

Mr. Phillips furnished the Committee on Adulteration with the following information in regard to the adulteration of snuff:—

"We have found, in different samples, common peat, such as you get from the bogs of Ireland; starch, ground wood of various kinds, fustic being most predominant; extract of logwood, chromate of lead, bichromate of potash, and various ochreous earths.

"We have also had samples of spurious snuff made up, and variously scented, to represent Scotch, Welsh, and Irish snuff, and which has been composed of the following substances:—sumach, umber, which is a dark earth, Spanish brown, and common salt. In another case we found peat, umber, and common salt. In another, ground coal, peat, and extract of logwood. In another, ground peat, yellow ochre, lime, and sand, the whole of them being more or less scented. I have no doubt they were made for the purpose of being mixed with other snuffs."

Besides the articles above enumerated the Excise have met with certain other substances.

From an Excise return of the seizures made during the two years 1851 and 1852, it appears that fourteen prosecutions were instituted against persons residing in various parts of the United Kingdom, for adulterating snuff with vegetable and earthy matters, or for having the materials for adulteration in their possession. On an examination of this return, it appears that the following substances were either detected or seized by the Excise authorities in the cases above referred to:—Powdered Columbo root, yellow ochre, quassia, red ochre, and gentian root, in one case; peat moss and earthy matter, in two cases; earthy matter and ground rhubarb leaves, in one sample; 12·11 per cent. of oxide of iron and sand, in one case; 30 per cent. of vegetable matter not tobacco, and powdered leaves of trees, each in one case; ground fustic wood, in two cases, one containing 25 per cent., the other 15 per cent.; in one sample wood and earthy matter was found, and in two other cases the materials used in the adulteration were not stated.

But it is not only with adulteration that the revenue has to contend, but also with *smuggling*.

It is particularly worthy of note that mention is not made in the return above referred to of the occurrence of red lead, chromate of lead, or bichromate. It would appear that the Excise only became acquainted with the fact of the use of those poisonous substances subsequent to the author's report on snuff.

Looking, then, at the whole of the results contained in this report, we would say that *the article snuff is subject to a very large amount of adulteration, and that of a kind which is not only detrimental to the revenue, but exceedingly injurious to health.*

Such striking and even startling results were hardly to have been anticipated; for when we consider the enormous revenue derived from tobacco, as well as the costly machinery employed to suppress adulteration, especially in this, and also in other exciseable articles, it might have been expected that the results would have been very different.

The Excise authorities are numerous and powerful; they possess a staff of analysts, and they have the liberty of entering upon any premises, and of seizing all suspected goods. It is clear, therefore, from the results contained in this report, as well as those of several previous ones, that these authorities, including the analysts employed by them, are by no means up to their work. We say it without boasting, but certainly with some degree of satisfaction, that, aided only by science, and supported by a firm resolution, we have done more to discover and check adulteration than the whole body of Excise authorities, the maintenance of which costs the country some hundreds of thousands of pounds annually. In those cases in which the Excise officers have prosecuted parties for the adulteration of snuff, they have rarely done so on purely scientific grounds, from the results of chemical and microscopical examination; but their proceedings usually have been based upon the seizure of the articles employed for adulteration on the premises of the manufacturer.

That foreign leaves or other vegetable substances should not have been found in the samples of snuff examined, excepting powdered orris root for scenting, is not surprising, when we consider the latitude which the law itself affords for adulteration with substances not vegetable, the Tobacco Act permitting, without limitation as to quantity, the addition of water, salt, and alkaline salts, and in the case of Irish and Welsh snuffs, lime water.

The disclosures made in this report clearly show that this Act should be extensively altered; that some limit should be assigned to the use of the substances just named, and that the prohibition should be extended to many articles not specially referred to in the Act.

It appears, then, as one great result of our examination of snuff, that the majority of the samples are adulterated, and this in such a manner as is in direct violation of the Excise laws, the parties being liable to very heavy penalties and imprisonment. Of the injurious character of some of the adulterations detected, not a doubt can be entertained. Chromate of lead, red lead, and bichromate of potash, are all highly poisonous, and when applied to soft mucous surfaces, such as those of the nose, they are readily absorbed into the system.

Since Government allows of the admixture of water, salt, alkaline salts, and lime water, without any limit as to the amount, it is extremely difficult in many cases to draw the line, and to say where adulteration with these substances begins.

On the Detection of the Adulterations of Snuff.

The method to be adopted in the examination of the different kinds of snuffs is as follows: — A portion of each is to be spread out upon a slip of glass and thoroughly wetted with water; all the larger particles picked out with a needle-point and removed to another slip;

these carefully pulled to pieces and scrutinised with the microscope, the dust or finer portion being also thoroughly examined under this instrument; and this process is to be repeated two or three times with each sample.

Peat, *woody fibre* including *fustic*, as well as *foreign leaves*, are all discoverable by means of the microscope.

100 grains of each of the snuffs are to be incinerated, the weight of the ash ascertained, and then analysed quantitatively for chloride of sodium or salt, for alkaline and earthy carbonates, sulphates, and nitrates, for iron and alumina, chromate of lead, oxide of lead, bichromate of potash, and for silica.

For the detection of *lead*, the snuff, after being moistened with a solution of carbonate of soda, is to be incinerated, the ash drenched with a little water, and the residue treated with a few drops of nitric acid, and tested with the usual reagents. The quantity may be determined from the sulphuret or sulphate of lead formed.

The following is a good method of proceeding, and by it we ascertain whether the metal is in the state of *chromate or oxxide*: —

The soluble portion of the ash having been removed, the remainder should be fused with a mixture of nitre and bisulphate of potash, the residue well washed with water, the solution filtered, evaporated, treated with hydrochloric acid, and, while at a boiling heat, with alcohol. If no green colour be produced, the absence of chromic acid may be inferred; if the colour does appear, the oxide of chromium must be precipitated by ammonia.

The residue left after the first washing is to be treated with a solution of ammoniacal tartrate of ammonia, by which means the sulphate of lead is taken up. This is precipitated with sulphuretted hydrogen, collected, dried, and weighed.

On treating the sulphuret of lead with nitric acid, and evaporating to dryness, an insoluble sulphate of lead is again obtained, and, on fusing this with carbonate of soda, and treating the insoluble residue with acetic acid, acetate of lead is formed, the solution of which gives a yellow precipitate with iodide of potassium, yellow with bichromate of potash, and white with dilute sulphuric acid.

If, on following the above methods of analysis, the green colour is produced on the addition of alcohol, but no lead found, then we may infer that *chromate or bichromate of potash* has been employed.

We will now inquire whether the Excise has succeeded in protecting the revenue from loss, in the adulteration of tobacco, which pays so heavy a duty to the state. As has already been shown, *cut* and *roll tobacco* is subject to considerable adulteration, while *snuff* is so to an enormous extent. Of forty-three samples subjected to examination, nearly the whole were adulterated, and in a very scandalous manner, with substances injurious to health. So much for the efficiency of the Excise in preventing the adulteration of tobacco and snuff.

It is questionable whether the Excise really possesses the requisite knowledge to detect many of the adulterations of tobacco. Some time since it certainly did not.

We learn from the Report by the Select Committee of the House of Commons on the tobacco trade, that so convinced were the manufacturers of London of the inability of the Excise officers to detect adulterations in tobacco, that they "proposed to the secretary to the Excise Board to send specimens of pure and of adulterated tobacco, that the Excise officers might convince the manufacturers of the power they had of detecting adulterations.

Under the authority of that Committee twelve samples of tobacco were prepared, and submitted to the Excise to be examined by them and reported upon; the examiners being Mr. Richard Phillips, Professor Graham, and Mr. George Phillips.

The substances and articles introduced into these samples were as follows:—rhubarb leaves, foxglove leaves, brown paper, syrup of sugar, saltpetre, alum, chicory root, Irish moss, carbonate of potash, sulphate of potash, carbonate of magnesia and carbonate of lime, terra japonica, refined sugar, common salt, nitrate of ammonia, chloride of potassium, and sugar of milk.

Now the only substances detected out of the above list by the examiners were the *rhubarb leaves*, the *brown paper*, and *sugar*; all the others remained undiscovered. Even of the articles actually detected the proportions given were in all cases very wide indeed of the mark; thus the 16 per cent. of rhubarb leaves introduced, were set down at 3·3 per cent., and the same error was committed in regard to the amount of sugar present.

In some cases the samples were alleged to be adulterated with sand, sugar, and crumb of bread, when either these substances were not present at all, or the samples were perfectly genuine.

Never, in fact, in the whole history of science, was a more lamentable exhibition of incompetence. There is not one of the vegetable substances or chemical compounds above enumerated, which might not have been readily discovered and identified.

PROPERTIES AND EFFECTS OF TOBACCO.

We will in the next place consider the effects of the use of tobacco upon the human frame, whether smoked, chewed, or employed in the form of snuff.

Tobacco owes its chief properties to the presence of two active principles, termed *nicotina* and *nicotianin*. The first of these, *nicotina*, is thus characterised: it is liquid and volatile, devoid of colour, with an acrid, burning taste, and possesses the strong odour of tobacco; to test-paper it shows an alkaline reaction: water, ether, alcohol, and the oils dissolve it. It combines with various organic and inorganic acids to form salts. 1000 grains of tobacco yield, according to the kind used, from 3·86 to 11·28 grains of nicotina. The action of nicotina on the human frame is that of an acrid, narcotic poison, causing giddiness and vomiting, and in doses of a few grains, death.

The properties of the latter, *nicotianin*, are as follow:—It is a concrete oily substance, having the smell of tobacco, and a bitter taste. It is volatile; the dilute acids and water do not dissolve it, but it is soluble in liquor potassæ and ether. In swallowing nicotianin, the same sensation is produced on the tongue and fauces as by tobacco. A grain administered internally, quickly caused giddiness, nausea, and retching. It also produces sneezing when applied to the nose. Six pounds of tobacco leaves furnish about eleven grains of nicotianin. It is also known as "*Concrete Oil of Tobacco*," and "*Tobacco Camphor.*"

Both these active principles and constituents have been shown by chemical analysis to be present in *the smoke* of tobacco; they are therefore undoubtedly not destroyed by the combustion of the tobacco, whether used in the form of cut tobacco or cigars, but in the act of smoking they are inhaled and thus drawn into the mouth, fauces, lungs, and even the stomach, especially when the saliva, impregnated with the tobacco smoke, is swallowed. Further, that these active constituents are actually absorbed, and make their way into the system, is proved, from the sickness, giddiness, and death-like faintness experienced by those who are unaccustomed to smoking; that they are absorbed to some degree, if not to the same extent, in the case of habitual smokers of tobacco is unquestionable, the difference in the effects experienced being due to the circumstance of the system becoming more inured to its use, and therefore less susceptible of its influence.

In the case of confirmed smokers, the effect of tobacco smoke is that of *a narcotic* After a very short and almost inappreciable period of excitement, the effect begins, and its tranquillising influence is experienced, pervading the whole system; the frequency and force of the pulse are diminished, as well as the tonicity of the muscles, particularly of the involuntary muscles, as is shown by the readiness with which the bowels act in most cases after smoking tobacco. The action of the skin is also often increased, but there is no evidence to show whether it exerts any sensible effect over other secretions, as those of the liver and kidneys. Bearing in mind the nature of the ordinary and more usual symptoms above referred to, produced by the smoking of tobacco, we are in a position to appreciate the effects of the continued use of tobacco in this form upon the human system.

In persons whose circulation is brisk, and who have an abundance of red blood—in other words, in the sanguine and the plethoric—in whom the functions of digestion and assimilation are active, we should say that this habit would be calculated to be productive of beneficial rather than injurious consequences, by lowering somewhat the tone of the circulation, and by promoting the secretion of the salivary glands and of the skin; also, perhaps, by moderating the activity of digestion.

In persons of weak circulation and digestion, in many of whom the habit of tobacco smoking is attended with great expectoration, there is no question but that the indulgence in this practice is in a high degree prejudicial to health, for it lowers still more the force of the circulation and the powers of digestion; while the great expectoration of saliva, a fluid which contains a large portion of animal matter, acts as an exhausting drain upon the system.

There is another class of persons on whom the practice of tobacco-smoking may possibly exert a beneficial effect—namely, those of nervous and irritable temperament,—especially those who are so from the over-excitement of business, rather than from disease: this would apply to a considerable number of residents in large towns and cities.

In those cases in which smoking is attended with great expectoration, it is probable that the constitutional effects of the tobacco are experienced in a far less degree, since very much of the nicotin and nicotianin is ejected with the saliva.

In countries where tobacco is grown, as in America, the pernicious effects of extreme indulgence in smoking are fully known and recognised. In America it is no uncommon circumstance to hear of coroners' inquests on the bodies of smokers, especially youths, the ordinary verdict being, "Died from excessive tobacco smoking."

But a very large proportion of tobacco smokers belong to none of the three classes of persons above referred to, being neither plethoric, dyspeptic, nor nervous and irritable, but are in the enjoyment of a good and sound state of health: to such persons we would say that the habit of tobacco smoking is useless and expensive, and simply panders to that spirit of self-indulgence which leads many to gratify the senses in a variety of ways.

The habit of smoking is often injurious in an indirect manner, by its acting as an inducement to drinking, and thus becoming the source of intemperance and its attendant evils. Indeed, too frequently these practices go together. "Smoking induces drinking, drinking jaundice, and jaundice death."

Many of the above remarks apply with greater force to the practice of tobacco chewing; in this case, no doubt, a larger quantity of the active principles of the tobacco make their way into the system; and this amount would be very much greater were it not for the fact that all chewers of tobacco expectorate largely and often injure themselves thereby.

The constitutional effects resulting from the use of tobacco in the form of snuff, when this is genuine, are certainly much less than in the case either of smoking or chewing tobacco; indeed, the effects are in most cases chiefly local. The nerves of the Schneiderian membrane are over stimulated; there is determination of blood to the part, and the membrane becomes thickened and insensible; at the same time the brain is roused to increased action. When any of the snuff taken makes its way into the fauces, as it very often does, it produces a certain amount of constitutional derangement, and often gives rise to dyspepsia. On first beginning to take snuff, sickness and faintness are induced in the same way as from tobacco smoking.

The chief local effects of the long-continued use of snuff are, impairment of the sense of smell, and to a less extent of that of taste; the voice also becomes much altered. These effects are not be attributed entirely to the tobacco contained in the snuff, but are also due to the irritating action of the alkalies and salts which enter into the composition of all snuff, as well as to the red and yellow ochre, red lead, chromate of lead, bichromate of potash, and many other injurious substances with which snuff is coloured. The poisonous nature of the chromates of potash, especially the bichromate, had long been suspected from the distressing symptoms produced in workmen engaged in many of the operations of dyeing. This led Mons. Duchatel, of Paris, to institute experiments with the view to investigate and determine the effects which this salt exerts on the animal economy, and the doses in which it proves injurious or poisonous. He found that, even in the small doses of from one twenty-fifth of a grain to one five-hundredth of a grain, it destroyed the lives of animals (dogs) on which he experimented, causing sickness, vomiting, and severe gastritis; and post-mortem examination showed the mucous membrane of the stomach and prima via to be much inflamed and completely softened.

Chromate of lead and red lead, although not poisonous to the same extent, are yet of a very deleterious nature, even in exceedingly minute doses. The metallic salts are constantly employed to give colour to a variety of articles, especially sugar confectionery; and many instances have been recorded of the fatal consequences to children who have partaken of sweets in which these dangerous substances had been used.

The quantity of chromate of lead and red lead contained in snuff as shown by the analyses is often very considerable, nearly 5 per cent. being sometimes found in it; sufficient — as appears from the following very interesting and highly important case, for the particulars of which we are indebted to Professor Erichsen — to give rise to the different symptoms and effects of poisoning by lead, as colic, paralysis, &c.

Case of Slow Poisoning by Snuff containing Lead, by Mr. Erichsen.

"Whilst on a professional visit in the country last March, I was requested to see a gentleman who had been invited down to a friend's country seat in the hope that change of scene and air would influence favourably an attack of paralysis, which was said to be of a rheumatic character; by which he had been disabled from work for many months past, and of which he despaired of recovering, having relinquished all treatment.

"I found the patient in bed, and somewhat exhausted by the journey down — a distance of nearly a hundred miles from his usual residence. He was peculiarly sallow, the complexion having almost an icteric tinge; but the countenance was lively and expressive, and the intellect as bright as usual.

"Mr. A. B. could stand and, if supported, could walk, though feebly and with much difficulty. He complained much of pains about the shoulders and the fleshy parts of the thighs and legs, and especially of burning sensations in the soles of his feet. The articulations all appeared healthy, no swelling or looseness was perceptible about any of them.

"I was, however, particularly struck with the appearance of the hands and arms, which were lying powerless on the coverlid of the bed. There was marked "wrist-drop" of both arms, the hands hanging flaccid and at right angles with the forearms, without the patient being able to extend or raise them in the slightest degree. There was, however, some slight power of extension left in the fingers, especially in those of the left hand. Though unable to extend the fingers, raise the hand, and scarcely having power to elevate the arm, Mr. A. B. could *flex* the fingers pretty firmly so as to give a tolerably good grasp to whatever was put into his hand. The index finger of the right hand seemed to be the most affected, and was permanently flexed.

"There was a very marked degree of wasting of the whole mass of the extensor muscles of the forearm, so that a longitudinal hollow corresponding to the interosseous space was perceptible down the whole length of the forearm, and a very deep and marked depression in the interspace between the first and second metacarpal bones. The hands were quite powerless, and the patient was unable to render himself the slightest assistance.

"The tongue was pale and flabby; and on examining the gums I found a deep blue-black or leaden-coloured line around the teeth, more marked about the molars.

"Digestion was much impaired. Appetite capricious, with much flatulence and occasional attacks of constipation with colicky pains.

"On inquiring into the history of the case, I learnt that Mr. A. B., who is much devoted to literary pursuits and habitually led a sedentary life, had for some years previously suffered from pains of a rheumatic or gouty character; that in May, 1853, he had been attacked by constipation and colic whilst lodging for a short time in a newly painted house. In August of the same year he had first begun to lose power in extending his arms, finding a difficulty in raising them to put on his coat; and from this time the paralytic symptoms gradually increased until they had assumed the degree in which I found them, when he had become reduced to a state of complete physical helplessness, though, as I have already observed, his powerful and clear intellect was as perfect as ever.

"On examining Mr. A. B., I was at once struck by the very marked 'wrist-drop,' more complete than I had ever seen before; the limitation of the paralysis to the extensors, which were greatly wasted; the existence of a blue line around the teeth; and the occurrence of occasional attacks of constipation and colic, together with flying pains in the fleshy parts of the body, with absence of all articular inflammation. These symptoms led me to the conclusion that Mr. A. B. was suffering from saturnine paralysis, and that he had been slowly poisoned by lead.

"The difficulty was, however, to ascertain how poisoning by lead could have been effected. With this view I made diligent inquiry into the patient's habits, the water he drank, the utensils he used, &c., but could not detect any source to which the presence of the mineral in the system could be traced, except that the first attack of colic and constipation had occurred whilst temporarily lodging in a house which smelt of fresh paint; but as he soon left this I thought it very insufficient to explain his continued and increasing sufferings. In the course of my inquiries, however, I found that he took snuff in considerable quantities. I accordingly emptied his box of its contents, and took them up to town with me with the view to further examination. The snuff was analysed by Professor Williamson, who immediately detected in it a considerable quantity of lead; and another supply having been procured from the shop at which Mr. A. B. was in the habit of purchasing it, was subjected to analysis by Dr. Garrod, who readily detected large quantities of the metal in it.

"Mr. A. B. was now put under treatment for saturnine paralysis. The snuff was left off; the bowels were kept open with the acidulated sulphate of magnesia; iodide of potassium was freely given in conjunction with strychnia, which was applied topically to blistered surfaces as well as administered by the hands; and galvanism was assiduously employed. Under this plan of treatment he gradually improved in all respects; the colicky symptoms rapidly disappeared, the muscular pains subsided, and the paralytic condition of the extensors was gradually removed, until at the end of July he was able to resume and to discharge public duties of a very onerous character with his usual ability and energy."

With the above sketch, we received from Mr. Erichsen a sample of the snuff which was the occasion of all the mischief. On analysis it was found to contain 1·2 per cent. of red oxide of lead; that is very much less than some of the other samples, the analyses of which have already been given.

But the case reported by Mr. Erichsen is by no means a solitary one: we have already been informed of others.

One of these cases was that of Mr. Fosbroke, surgeon, of Bidford, Alcester. The particulars, as kindly furnished by Mr. Fosbroke himself, are as follow: —

"In the latter part of the year 1852, I suffered from an attack of what was at the time regarded as simple constipation of the bowels, but attended by considerable pain, especially about the umbilicus, of a twisting character. A medical friend who visited me ordered a dose of morphia, followed by an active aperient, which relieved all the symptoms. In the course of a short time my general health began to fail; I constantly experienced a sensation of sinking about the epigastrium; the bowels became irritable, and I invariably passed liquid motions. After spending a short time from home in May, 1854, I was suddenly attacked by similar symptoms I had before suffered from, but of a more severe character. The pain was most excruciating, the bowels more obstinate, and were many days before they were relieved, upon which all the symptoms subsided. I now noticed some trembling of the hands, which, however, soon passed off; but from this time every thing I did was by an effort most painful. The appetite failed, I became much thinner, had palpitations of the heart, constant pains in the lower extremities, and was little refreshed by sleep. Matters continued in this state until October 15th, when, being engaged in writing late in the night, I was suddenly (in a moment, in fact) surprised to find that I had no command over the ring finger of the right hand, that it dragged on the paper; and in a few days the other fingers, as well of those of the left hand, became similarly affected. The extensors of the thumbs and wrists escaped. I was then fully impressed with the idea that it must arise from lead, and I consulted Dr. Thomson, of Stratford-on-Avon, who has paid much attention to the subject of lead poisoning. He at once told me there could be no doubt on the subject; the blue line was well marked on the edges of the gums. In the course of the same week I had a third attack, much more severe than either of the preceding ones; the intensity of the pain was indescribable, and I was only comparatively easy when in a bath of almost boiling water. The bowels, as before, did not act, and required various aperients for forty-eight hours before any effect was produced. Castor oil with laudanum, in large doses, and the use of injections of turpentine, at last gave relief to them. I was then for some time tormented by a fixed pain in the small of the back, and extending to the lower extremities, caused possibly by the action of the turpentine on the kidneys. Dr. T. saw me at this time, when paralysis of the upper extremities had gone on so far that I was unable to turn in bed. He most kindly interested himself in my case, and instituted a most minute inquiry as to what I took different from my family, and at once fixed on the article of snuff as the probable source from which the system had been impregnated. Subsequent investigation fully confirmed his view. My health is now perfectly restored, nothing remaining but a trifling weakness of the extensors of the fingers.

"The treatment, in the first instance. was sulphuric acid and alkaline sulphates. Iodide of potassium produced no very marked benefit until galvanism was conjointly tried with it, under which plan I was in a few months fully restored to health."

In the letter which accompanied the sketch of the case above given, Mr. Fosbroke remarks: —

"Perhaps it may be interesting in some degree, in addition to what I stated respecting myself, if I inform you that my father, who is now between 70 and 80 years of age, took the same snuff, and has been incurably paralysed for many years past. No opinion was given by any medical man he consulted as to its origin. He had discontinued the use of snuff for several years previous to my case occurring, and has now much better health, with exception of the powerless condition of the arms."

In a second communication, Mr. Fosbroke furnishes the following further information: "I forgot to say, respecting my father's case, that about four years ago he suffered most dreadfully from sciatica, which confined him to bed for several months, and that Dr. Thomson then visited him, and pointed out that lead had occasioned all the mischief, but that from its insidious introduction into the system from whatever source, and the length of time that had elapsed, little could be done beyond relieving his present sufferings, which fortunately was effected by sulphuric acid. From distaste he gave up snuff-taking, and has had no return of a similar attack.

"A gentleman in this neighbourhood took the same snuff (Bolongaro, from Taddy's, London), and complained of inability to raise the left arm for some time previous to his death."

A sample of the snuff taken by Mr. Fosbroke yielded on analysis distinct evidences of the presence of lead, but not in amount nearly so great as the previous and many other of the snuffs examined.

Another case was referred, about a year since, to Dr. Letheby; it was that of a gentleman who presented all the symptoms of lead-poisoning. An analysis of the snuff, brown rappee, which he took, led to the discovery of the source of the poison.

At the last meeting of the British Association, it was stated, in a discussion on poisoning by snuff, that many persons had been injured by the lead received into the system through the snuff taken. We have thus, in the case of snuff, another striking example of injury to the public health arising out of the practice of adulteration.

But the practices of smoking and chewing tobacco, and of snuff-taking, are objectionable on other grounds than those relating to health. The dwelling and clothes of the smoker are impregnated with the heavy nauseating odour of the tobacco, particularly offensive to those who have a nice sense of smell, and who are not themselves tobacco smokers. Indeed, the moral and domestic objections to smoking are of the strongest kind.

In the case of the chewing of tobacco the practice is rendered disgusting by the dark, unnatural, and disfiguring stain which an indulgence in this habit imparts to the teeth, and by the character of the liquid which is constantly ejected.

Snuff-taking is an equally dirty habit; for not only are the nostrils constantly filled with the brown and earthy-looking powder, but the fauces at well as the stomach come in for their share of it; the face is often smeared with it, the nails filled with it, and the shirt and clothes also stained and dirtied by its use.

Other views, which may be taken of these practices, are the expense and loss of time which they involve. With regard to the expense and loss of time sacrificed in snuff-taking, the following curious estimate has been made by Lord Stanhope:—

"Every professed, inveterate, and incurable snuff-taker, at a moderate computation, takes one pinch in ten minutes. Every pinch, with the agreeable ceremony of blowing and wiping the nose, and other incidental circumstances, consumes a minute and a half. One minute and a half out of every ten, allowing sixteen hours to a snuff-taking day, amounts to two hours and twenty-four minutes out of every natural day, or one day out of every ten. One day out of every ten amounts to thirty-six days and a half in a year. Hence, if we suppose the practice to be persisted in for forty years, two entire years of the snuff-taker's life will be dedicated to tickling his nose, and two more to blowing it." The expense of snuff, snuff-boxes, and handkerchiefs is also alluded to, and it is calculated "that by a proper application of the time and money thus lost to the public, a fund might be constituted for the discharge of the national debt."

It should also be remembered that such unclean and disgusting practices, although they may lose much of their offensiveness, from repetition, to the parties who themselves practise them, yet in most cases they are most disagreeable to those who do not participate in them, and who are forced to be spectators of them.

For much interesting and curious detail relating to Tobacco, the reader is referred to "A Dissertation on the Use and Abuse of Tobacco," by Adam Clarke. These remarks occur near its conclusion:—"To those who are not yet incorporated with the fashionable company of tobacco consumers I would say, Never enter. To those who are entered I would say, Desist. First, for the sake of your health, which must be materially injured, if not destroyed by it. Secondly, for the sake of your property, which, if you are a poor man, must be considerably impaired by it. But, supposing you can afford this extra expense, consider how acceptable the pence (to go no farther) which you spend in this idle and unnecessary employment would be to many who are often destitute of bread, and to whom one penny would sometimes be as an angel of God. Thirdly, for the sake of your time, a large portion of which is irreparably lost, particularly in smoking. Have you any time to dispose of—to murder? Is there no need of prayer, reading, study? Fourthly, for the sake of your friends, who cannot fail to be pained in your company for the reasons before assigned. Fifthly, for the sake of your voice, which a continuance in snuff-taking will infallibly ruin, as the nasal passages are almost entirely obliterated by it. Sixthly, for the sake of your memory, that it may be vigorous and retentive; and for the sake of your judgment, that it may be clear and retentive to the end. Lastly, for the sake of your soul. Do you not think that God will visit you for your loss of time, waste of money, and needless self-indulgence? Have you not seen that the use of tobacco leads to drunkenness? Do you not know that habitual smokers have the drinking vessel often at hand, and frequently apply to it? Nor is it any wonder; for the great quantity of necessary moisture which is drawn off from the mouth, &c. by these means must be supplied some other way. You tremble at the thought: well you may, for you are in great danger. May God look upon you, and save you before it is too late! It was this view of the subject which led Mr. Sylvester to imagine that the plant derived its name from Bacchus, the heathen god of the drunkards.

"'Which of their weapons hath the conquest got,
Over their wits; the pipe, or else the pot?
For even the derivation of the name
Seems to allude to, and include the same;
Tobacco, as Τω Βακχω one would say;
To cup-god Bacchus dedicated ay.'

"It is with pain of heart that I am obliged to say, that I have known several who, through their immoderate attachment to the pipe, have become vile sots. There are others who are walking unconcernedly in the same dangerous road. I tremble for them. Should this fall into their hands, may they receive it as a warning from God!"

The Royal author, King James, concludes his celebrated "Counterblaste to Tobacco" in these words:—

"Have you not reason, then, to be ashamed and to forbear this filthy novelty, so basely grounded, so foolishly received, and so grossly mistaken in the right use thereof. 'A custom, loathsome to the eye, hateful to the nose, harmful to the brain, dangerous to the lungs, and in the black stinking fume thereof, nearest resembling the horrible Stygian smoke of the pit that is bottomless!'"

Customs' duties are—

Unmanufactured, stemmed or stripped,	3*s*.	per lb.
„ unstemmed -	3*s*.	„
Manufactured, or Cigars - -	9*s*.	„
Snuff - - - - - -	6*s*.	„

And 5 per cent. on all.

Stalks and flour of tobacco prohibited.

There were entered for home consumption—

	In 1854.	In 1855.	In Nine Months of 1856.
	Lbs.	Lbs.	Lbs.
Stemmed - - - -	17,030,637	15,741,292	11,714,782
Unstemmed - - - -	13,306,403	14,533,709	12,171,099
Manufactured and snuff - -	206,495	218,583	187,685

OPIUM, AND ITS ADULTERATIONS.

We have in the present article to detail the results of an examination of numerous samples of *opium*, one of the most important articles contained in the whole materia medica.

The substance known as opium is the milky juice of the capsule or seed vessel of *papaver somniferum*, evaporated and inspissated by exposure to the action of light and air, during which it acquires its dark colour and gummy consistence.

The opium poppy is an annual herbaceous plant, attaining a height usually from four to six feet; there are two well-marked varieties of it, and which by some botanists are even considered to be distinct species — namely, the *black* and the *white*. By far the largest proportion of the opium of commerce is obtained from the latter or white variety.

The black variety, *papaver somniferum nigrum*, derives its name from the colour of its seeds, which are black.

The habitat of the opium poppy is Asia and Egypt, but it is occasionally found growing wild in some parts of England, having probably escaped from gardens in which it is frequently grown for the sake of its flowers. It is cultivated for the purposes of commerce in Hindostan, Persia, Asia Minor, including Turkey, and in Egypt.

According to Dr. Royle, the black variety is cultivated in the Himalayas. In Europe, the opium poppy is likewise grown to some extent, but for different purposes — namely, for the sake of the capsules or poppy-heads, and its seeds, which yield a sweet and innocuous oil, much employed in painting and watch-making, in consequence of its being less liable than other oils to oxidise or to become rancid. The London market is chiefly supplied with poppy heads from the neighbourhood of Mitcham in Surrey.

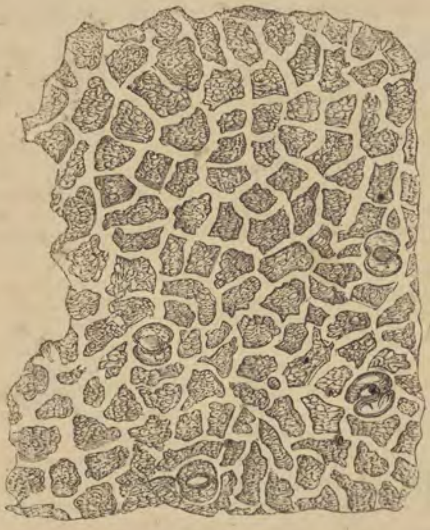
Poppy heads or capsules are ordered in the London and Dublin Pharmacopœias to be gathered when quite ripe, while the Edinburgh College directs them to be collected whilst still immature, in which state they are much more active. A decoction of the dried poppy capsule is rendered brown on the addition of sesquichloride of iron, owing to the formation of a meconate of iron; while with nitric acid a slightly orange tinge is developed, indicative of the presence of morphia.

Structure of the Poppy Capsule.

Since the poppy capsule is employed somewhat extensively, as will appear hereafter, in the adulteration of opium, it will be proper to describe its minute organisation or intimate structure, as ascertained by the microscope; so that the observer, in subjecting any sample of opium to a microscopic examination, may be able readily to identify those tissues frequently contained in it which are referable to the poppy capsule.

The poppy capsule is of a more or less globose or ovate globose form, it varies in size from a hen's egg to an orange, and is of a light, spongy, and papyraceous texture. It is one-celled, consisting of numerous carpels enclosed in a membranous production of the thalamus, and furnished with placentæ, which form dissepiments in the interior of the capsule, the number and position of which correspond with the carpels. Thin sections of the external surface of the capsule, examined under the microscope, are seen to be composed of small, angular cells, having exceedingly well-marked, broad walls or parietes, with here and there a few rounded stomata. It is necessary that the microscopic examiner should be thoroughly acquainted with this structure, since it is chiefly the external portion of the capsule which enters into the adulteration of opium. The resemblance of this membrane to the cells of the membrane forming the

Fig. 199.

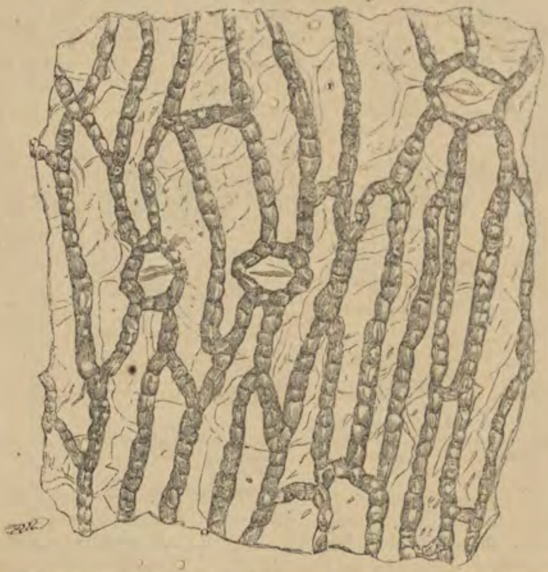


Portion of the *external* surface, *epicarp*, of the POPPY CAPSULE. Drawn with the Camera Lucida, and magnified 220 diameters.

surface of the grain of wheat is very great. so that a person might easily mistake the one for the other. *Fig*. 199.

The structure of the membrane which lines the interior of the capsule, and which is situated between the dissepiments, is very different: it consists of very large cells, of an elongated and irregular form, but mostly becoming narrow towards either extremity; their parietes are very thick, and beaded; this membrane is also furnished with a few angular stomata. *Fig*. 200.

Fig. 200.



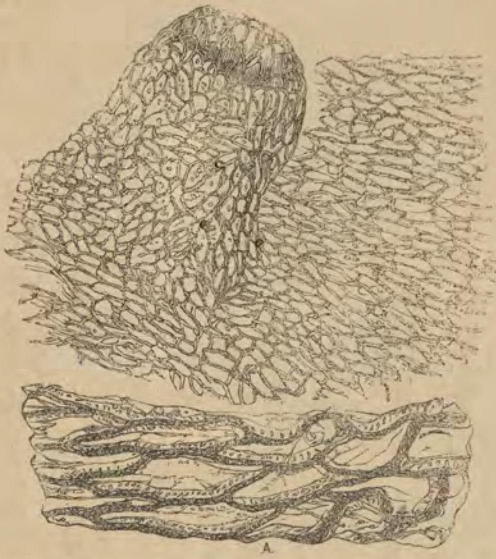
Portion of *inner* surface of the POPPY CAPSULE, *endocarp*. Magnified 220 diameters.

In longitudinal sections, passing through the entire thickness of the capsule, we obtain a side view of the cells which form the outer and inner portions of the capsule, the space between the two being composed of a loose and open cellular tissue, which imparts the sponginess to the capsule, and which is traversed here and there with bundles of dotted ducts, spiral vessels, and woody fibre.

The structure of the dissepiments or placentæ, again, differs entirely from that of the internal wall of the capsule. The surface of each dissepiment on both sides presents numerous dark points or specks;

these consist of short, raised projections, spermophores, each of which originally gave support to a distinct seed, which in the ripe capsule is found to be usually detached. Those portions of the surface of the dissepiment, lying between the spermophores, are made up of cells, which, though rather large, are much smaller than those forming the internal surface of the capsule; they are somewhat elongated, being usually narrow at each end; their margins or parietes are dotted, and there are no stomata; the spermophores or projections supporting the seeds are composed of similar cells. *Fig.* 201.

Fig. 201.

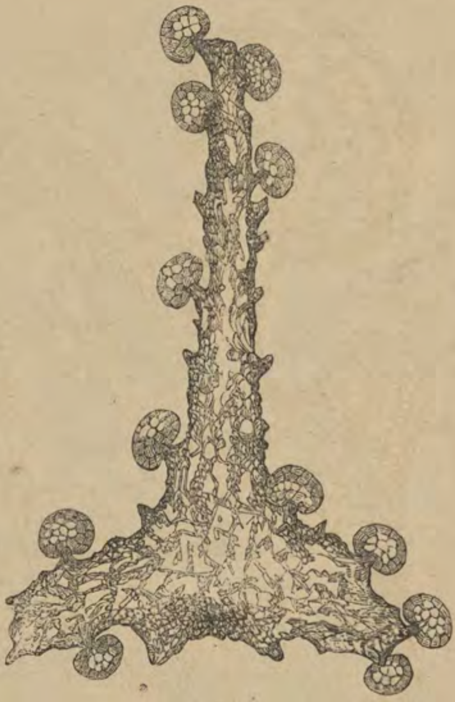


Portion of surface of one of the *placentæ* or *dissepiments* of the POPPY CAPSULE, showing one of the spermophores. Magnified 60 and 220 diameters.

In transverse sections of the dissepiment viewed with a two-inch object glass, the projections or spermophores are well seen, as also the manner in which the seeds are supported and distributed. *Fig.* 202.

In sections of the same, viewed with a half-inch object glass, the intimate structure of the dissepiments may be followed out. The central or spongy part, which swells greatly when immersed in water, consists of tubular cells running in all directions, so arranged as to leave considerable interstices or areolæ between them, together with bundles of woody fibre and vessels, one of which bundles passes up through the centre of each spermophore. *Fig.* 203.

Fig. 202.



Transverse section through the thickness of a dissepiment of POPPY CAPSULE, showing the spermophores with the seed attached. Magnified 10 diameters.

The structures which enter into the composition of the poppy seed are shown in *figs.* 203. and 204.

Collection of Opium.

The process by which opium is obtained from the poppy capsule is similar in principle in all countries, although subject to various modifications; it consists in making incisions into the half-ripe capsules, and in collecting the juice after it has become hardened and darkened in colour by exposure to air and light. Mons. C. H. Texier [*] thus describes the process of obtaining opium followed in Asia Minor:— "A few days after the flower has fallen, men and women repair to the fields, and cut the head of the poppy horizontally, taking care that the incisions do not penetrate the internal cavity of the shell. A white substance immediately flows out, and collects in tears on the edges of the cuts. In this state the field is left for twenty-four hours, and on the following day the opium is collected by large blunt knives. Each head furnishes opium once only, and that to the extent of a few grains.* Thus collected, opium has the form of a glutinous and granular jelly. It is deposited in small earthen vessels, and beaten up with saliva. When asked why water was not employed in place of

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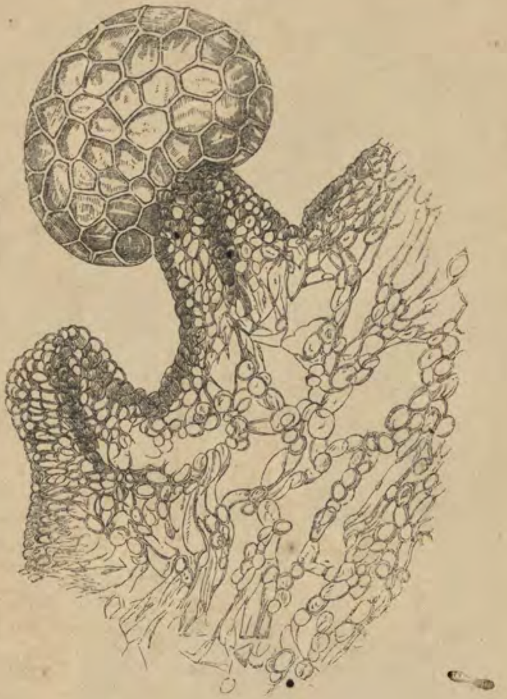
[*] Journ. de Pharm., xxi. 196.

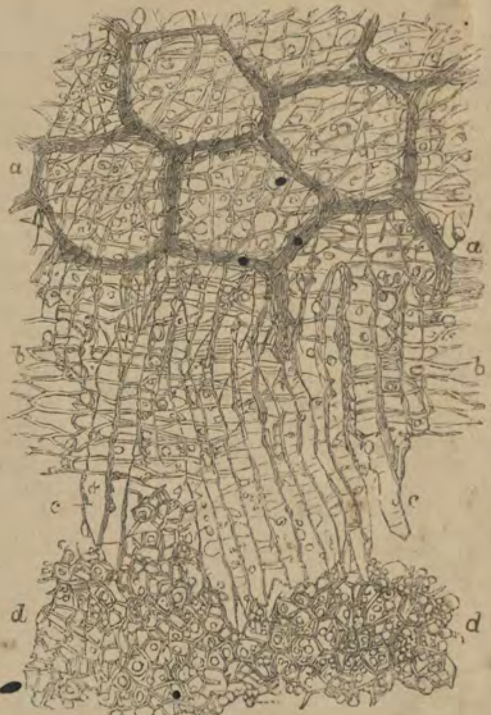
Fig. 203.



Transverse section of dissepiment of POPPY CAPSULE, showing two of the spermophores with a seed attached. Magnified 100 diameters.

saliva, the answer was that water caused it to spoil. It is afterwards enveloped in dry leaves, and in this state it is sold. The seed of those poppies which have yielded opium are equally good for sowing the following year."

Fig. 204.



Fragment of POPPY SEED, showing portions of the three membranes which compose the husk of seed, as well as the cells containing the oil in globulæ, which form the substance of the seed itself. Magnified 100 diameters.

In Persia, according to Kæmpfer, the incisions are made crosswise by a fine-edged knife; while Kerr states that in the province of Behar "two longitudinal double incisions are made upon each half-ripe capsule, passing from below upwards," care being taken that the internal cavity of the capsule be not penetrated.

A very interesting and important account of the cultivation and manufacture of Indian opium has been published by Dr. Eatwell, and from which we much regret that our space does not permit us to quote largely. A long abstract of the communication referred to will be found in the author's Report on Opium published in "The Lancet."

Analysis of Opium.

The united labours of various chemists have shown that opium is one of the most complex of vegetable substances with which we are at present acquainted. To give anything like a complete account of the analysis of opium, and of the labours which have been bestowed upon it, would itself occupy a volume; we must therefore content ourselves with such a description of the composition of that drug as is necessary to enable the inquirer to ascertain for himself its strength and purity.

Chemists have succeeded in detecting in, and isolating from, gum opium the following active principles and constituents:—*morphia, narcotina, codeia, narceia, meconine, thebia or paramorphia, pseudo-morphia? meconic acid, brown acid extractive, sulphuric acid, resin, fat, oil, gummy matter, caoutchouc, albumen, odorous principle,* (volatile oil?) *and lignin;* to these may be added another substance not included, so far as we are aware, in any of the analyses of opium yet given, although it is frequently contained in it in large amount; we refer to *glucose* or *grape sugar.*

Of the more active principles of opium the most important belong to the class of alkaloids, as *morphia* and *narcotina*, and form bases; while others readily unite with oxygen, and play the part of acids, some of which enter into combination with the alkaloids. The most complete analyses of opium which have as yet been published are those by Mulder, Schindler, and Biltz.

*Mulder's Analysis.**

	Smyrna Opium.				
1. Morphia - - -	10·842	4·106	9·852	2·842	3·800
2. Narcotina - - -	6·808	8·150	9·360	7·702	6·546
3. Codeia - - -	0·678	0·834	0·848	0·858	0·620
4. Narceine - - -	6·662	7·506	7·681	9·902	13·240
5. Meconine - - -	0·804	0·846	0·314	0·380	0·608
6. Meconic acid - - -	5·124	3·968	7·620	7·252	6·644
7. Fat - - - -	2·166	1·350	1·816	4·204	1·508
8. Caoutchouc - - -	6·012	5·026	3·674	3·754	3·206
9. Resin - - - -	3·582	2·028	4·112	2·208	1·834
10. Gummy extractive - -	25·200	31·470	21·834	22·606	25·740
11. Gum - - -	1·042	2·896	0·698	2·998	0·896
12. Mucus - - - -	19·086	17·098	21·068	18·496	18·022
13. Water - - - -	9·846	12·226	11·422	13·044	14·022
Loss - - - -	2·148	2·496	0·568	2·754	3·332
Total - - -	100·000	100·000	100·000	99·000	99·998

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* Pharm. Central-Blatt für 1837, s. 574.

Schindler's Analyses.[*]

	Smyrna Opium.	Constantinople Opium.	Egyptian Opium.
Morphia - - - - - -	10·30	4·50	7·00
Narcotina - - - - - -	1·30	3·47	2·68
Codeia - - - - - -	0·25	0·52	90·32
Narceine - - - - - -	0·71	0·42	
Meconine - - - - - -	0·08	0·30	
Meconic acid - - - - -	4·70	4·38	
Resin - - - - - -	10·93	8·10	
Bassorin, caoutchouc, fat, and lignin - -	26·25	17·18	
Salts and volatile oil - - - -	3·60	3·60	
Lime and magnesia - - - - -	0·47	0·42	
Alumina, oxide of iron, silica, and phosphate of lime - - - - -	0·24	0·22	
Brown acid, soluble in alcohol and water -	1·04	0·40	
Brown acid, soluble in water, gum, and loss -	40·13	56·49	
Total - - - - -	100·00	100·00	100·00

Biltz's Analyses.[†]

	Oriental Opium.	Indigenous Opium.	
		From a Nigrum.	From β Album.
Morphia - - - - - -	0·25	20·00	6·85
Narcotina - - - - -	7·50	6·25	33·00
Meconic acid (impure) - - - -	13·75	18·00	15·30
Bitter extractive - - - - -	22·00	8·50	11·00
Deposit - - - - - -	7·75	4·75	2·20
Albumen - - - - - -	20·00	17·50	13·00
Balsamic matter - - - - -	6·25	7·65	6·80
Caoutchouc - - - - -	2·00	10·50	4·50
Gum, with lime - - - - -	1·25	0·85	1·10
Sulphate of potash - - - - -	2·00	2·25	2·00
Lime, iron, alumina, and phosphoric acid -	1·50	1·85	1·15
Woody fibre - - - - -	3·75	0·80	1·50
Ammonia, volatile oil, and loss - -	3·00	1·10	1·60
Total - - - - -	100·00	100·00	100·00

Of the numerous constituents of opium it is only necessary, for the purpose we have in view,—namely, the detection of adulteration,—that we should be acquainted with the properties of, and methods of obtaining, morphia, narcotina, and meconic acid.

Morphia exists in opium, chiefly in combination with meconic and sulphuric acids. Pure morphia presents itself in the form of transparent, right rhombic, prismatic crystals. It has an alkaline reaction, as shown by turmeric and reddened litmus papers; it is nearly insoluble in cold water, to which it imparts a degree of bitterness; boiling water dissolves a little more than one-hundredth part of morphia. It is soluble in forty parts of cold absolute alcohol; and thirty parts of boiling alcohol, but it is insoluble, or nearly so, in ether. It is soluble in the oils (fixed and volatile), in solutions of soda and potash, and also, but in much smaller quantity, in solution of ammonia; lastly, it readily dissolves in sulphuric, hydrochloric, and acetic acids.

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[*] Pharm. Central-Blatt für 1834, s. 754.
[†] Pharm. Central-Blatt für 1831, s. 757.

The Dublin College now admits morphia amongst its pharmaceutical preparations. It directs the morphia to be precipitated by the addition of chloride of calcium to a concentrated aqueous infusion of opium; the precipitate is dissolved in boiling water, and a slight excess of solution of ammonia added; the precipitate which is now thrown down is to be collected and washed with distilled water, and finally dried.

The following, perhaps, is one of the best methods of obtaining morphia in a state of purity; it is a modification of the process recommended by Thiboumary. To the watery extract of opium solution of ammonia is to be added, care being taken that it is not in excess; the precipitate thus thrown down, after being washed with water and proof spirit, is to be boiled with animal charcoal and rectified spirit; the solution is to be filtered and evaporated, by which means morphia in crystals is procured. The morphia obtained by the above process is not absolutely pure, but contains narcotina, which may be thus got rid of:—After the precipitate on the filter has been washed with water, dried, and mixed with proof spirit, acetic acid is to be added drop by drop until the solution slightly reddens litmus; the morphia will be taken up, but not the narcotina; the former is to be again precipitated by ammonia.

Morphia and its salts are reddened by nitric acid, with which they form an orange-red solution; this is darkened by adding excess of ammonia, but becomes yellow after a time. Neutral sesquichloride of iron poured on morphia renders it blue, as also its salts if concentrated. If an excess of water, or acids or alkalies, be added to this blue compound, the colour becomes destroyed. The most delicate test for the presence of morphia or its salts is chloride of gold, the addition of a few drops of which to the solution, throws down a yellow precipitate, which is redissolved on shaking. If a little liquor potassæ be now added, it becomes first greenish, then bluish violet, and lastly, purple.

Narcotina.—The greater part of narcotina is said to exist in opium in a free state, as it is removable by ether without the aid of either acids or alkalies. The properties of narcotina do not appear to be as yet fully and satisfactorily determined; but there is reason to believe that in its pure state it is possessed of but little activity. Dr. Roots administered it in doses, gradually increased to a scruple, without any ill consequences ensuing.

Narcotina is dissolved by nitric acid, with which it forms an orange-coloured solution, and is turned yellow by sulphuric acid. Vegetable colours are not affected by it, by which it is easily distinguished from morphia. It does not dissolve in cold water, but is soluble in 400 parts of boiling water; cold alcohol takes it up sparingly, but it dissolves in twenty-four parts of boiling alcohol; it is likewise soluble in ether and the volatile oils.

Meconic Acid.—This is usually prepared by heating meconate of lime in hot water with hydrochloric acid, which, on cooling, deposits crystals of meconic acid. When pure, it occurs in white, transparent micaceous scales, which are soluble in four times their weight of boiling water, but at this temperature water decomposes it. Cold water dissolves a smaller quantity of meconic acid, but it is entirely soluble in alcohol.

Meconic acid reddens the neutral sesquisalts of iron, forming meconate of sesquioxide of iron; but this red colour is destroyed by alkalies, protochloride of tin, and nitric acid aided by heat. Ammonio-sulphate of copper throws down a green precipitate (meconate of copper), and it furnishes white precipitates, which are soluble in nitric acid, with acetate of lead, nitrate of silver, and chloride of barium. Meconic acid is not reddened by chloride of gold. It should be remembered that the acetates, sulphocyanides, and some other substances equally with meconic acid possess the power of communicating a red colour to the sesquisalts of iron.

For a further account of the characters and properties of the remaining constituents of opium, the reader is referred to the concluding part of the third edition of Pereira's "Elements of Materia Medica."

Varieties of Opium.

Several varieties of opium are imported into this country, and are met with in commerce. Of these, the following are the principal:—

SMYRNA, TURKEY, OR LEVANT OPIUM.—This occurs in irregular, rounded, or flattened masses of various sizes, but rarely exceeding two pounds in weight, enveloped in leaves, and with rumex capsules adhering to the surface; some of the flat cakes are not furnished with capsules, and in this state somewhat resemble Constantinople opium. When first imported, the masses are soft, and of a reddish-brown colour, but by keeping they become hard and blackish; it breaks with a waxy lustre; its odour is strong, its taste bitter, acrid, nauseous, and persistent. M. Guibourt considers the masses to be made up of agglutinated granules or tears, and he regards this character as a test of purity. It yields more *morphia* and *meconic* acid than either Constantinople or Egyptian opium; the average quantity of morphia obtainable in from it is about eight per cent. The narcotine may be estimated at somewhere about four per cent. Merck * examined five kinds of Smyrna opium; from the worst he obtained three to four per cent. of morphia; from the best 13 to 13·5 per cent.

Constantinople Opium.—Of this kind of opium Professor Guibourt gives the following description:—"There are two sorts of it—one in very large irregular cakes, which are flattened like the Smyrna opium; this is of very good quality. The other is in small, flattened, regular cakes, of a lenticular form, from two to two inches and a half in diameter, and covered with the poppy leaf, the median nerves of which divide the disk into two parts. It has an odour similar to the preceding kind, but more feeble; it blackens and dries in the air. It is more mucilaginous than Smyrna opium." The cakes are never covered with rumex capsules. Constantinople opium is inferior to the Smyrna kind, but superior to the Egyptian opium. Guibourt states that it yields only half the morphia procurable from Smyrna opium, but it furnishes more morphia than the Egyptian opium. This statement does not agree, however, with the experience of Mr. Duncan, of Edinburgh, Dr. Christison and Merck, all of whom obtained very large quantities of hydrochlorate of morphia from it; these differences probably depend upon the unequal quality of the opium produced in various portions of the Turkish empire, and which, being exported from thence, bears the name of Constantinople opium.

Egyptian Opium.—It occurs in round flattened cakes, of about three inches diameter, covered externally with the vestiges of some leaf; it is usually very dry; it is distinguished from the two preceding varieties by its reddish colour, analogous to that of Socotrine or hepatic aloes. Some very inferior qualities are sometimes offered for sale, and which appear to the sight and touch to be largely adulterated. It does not blacken by keeping, and its odour is less strong; by exposure to the air it usually becomes soft. Egyptian opium is for the most part inferior to either Smyrna or Constantinople opium, but its strength and quality are not uniform. Guibourt states that it yields only five sevenths of the morphia procurable from Smyrna opium; the morphia obtained is purified with great difficulty. The watery infusion of this opium possesses a distinct odour of acetic acid.

Trebizond or Persian Opium.—Some years since a quantity of this opium was imported into this country from Trebizond. It was in the form of sticks, rendered somewhat angular by pressure, about six inches long, and half an inch in diameter, enveloped in smooth, shiny paper, and tied with cotton. Its colour is similar to that of Socotrine aloes; its odour is stronger than that of the Egyptian kind, but less than Smyrna opium; it is very inferior.

Indian Opium.—There are three varieties of this kind of opium met with in commerce, under the names of *Malwa*, *Benares*, and *Patna* opium; the last two are not to be distinguished from each other, and may be included under the one head of Bengal opium.

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* Pharm. Central-Blatt, 36.

Bengal Opium is brought into this country in balls, each of about three and a half pounds in weight; and which are packed in chests, each holding about forty balls. They are hard, globular, and about as large as a child's head. They are coated externally with the petals of the poppy, fastened together by means of a paste called *lewah;* this covering, though disposed in layers, is firm, and weighs about fourteen ounces. On removing this, the opium is found to be of the consistence of a soft, homogeneous extract of a blackish brown colour; its odour and taste are strong, and it rapidly becomes mouldy on exposure to air. *Benares and Patna* opiums are exported from Calcutta; the former is most esteemed by the Chinese. Dr. Smytten* procured only $2\frac{1}{2}$ or 3 per cent. of morphia from Bengal opium; but it has been estimated by Mr. Morson that Benares opium contains rather more than half the quantity of morphia contained in good Turkey opium; while, from a table given in Dr. Eatwell's work on Opium, it appears that the average quantity of morphia yielded by Benares opium in the season 1845—46 was 2·48 per cent., and of narcotina, 5·26 per cent.: in 1846—47, morphia, 2·38; narcotina, 4·52 per cent.: in 1847—48, morphia, 2·20; narcotina, 5·68 per cent.: and in the season of 1848—49, the average per cent. was 3·21 morphine, and 4·06 narcotine. These results show that Benares opium is somewhat deficient in morphia but rich in narcotina.

Garden Patna Opium.—This kind of opium is imported in square cakes of about three inches in diameter each way and one inch thick, and wrapped in thin plates of mica. Professor Guibourt describes it as "having the appearance of a well-prepared, shiny, dry, pharmaceutical extract; its colour is blackish brown, and its odour not so strong as that of Smyrna opium."

Malwa Opium.—There are two varieties of Malwa opium. It was formerly considered to be of inferior quality, but it is at the present time much esteemed. One variety consists of round flattened cakes of about ten ounces in weight, and is packed in coarsely-powdered poppy petals. It is of moderately firm consistence, and of a homogeneous texture; its colour is dark brown, and the smell resembles somewhat that of Smyrna opium. The other variety is met with in flattened cakes without any outside coating; externally it is of a dull, opaque, blackish brown colour, but the interior is soft and deeper in colour; its odour is somewhat similar to, though not so powerful, as Smyrna opium. It yields only one third the quantity of morphia furnished by Smyrna opium. Dr. Smytten obtained only from 3 to 5 per cent. of morphia, but from finer samples as much as $7\frac{3}{4}$ to 8 per cent.

Cutch Opium.—This occurs in small cakes, rather more than one inch in diameter, and appears to be enclosed in fragments of leaves; its odour is not so strong as that of Smyrna opium.

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* Trans. of the Med. and Phys. Soc. of Calcutta, vi.

Kandeish Opium is imported in round flattened cakes about half a pound weight each. It is hard, brittle, nearly black, and breaks with a gritty or granular fracture. According to Mr. Solly, 100 grains furnished 72 grains of soluble matter, and about 7 grains of morphia.

ENGLISH OPIUM.—This opium is met with in flat cakes or balls, covered with leaves. In appearance it more resembles the best Egyptian opium than any other kind; its colour is like that of hepatic aloes, and it possesses the peculiar smell of opium moderately strong. From one sample of English opium, Mr. Hennell[*] obtained as much as 7·57 per cent. of morphia, while from Turkey opium he only procured 7·0 per cent. Mr. Morson[†] obtained 4·4 per cent. of morphia and 2·53 of narcotina from another sample. Mr. Young[‡] states that English opium is stronger than ordinary commercial opium, six ounces of the former being equal to eight of the latter.

FRENCH OPIUM.—This kind of opium is described by M. Pelletier[§] as being of a deep reddish brown colour, and brittle when dry. Its taste was somewhat different to that of Smyrna opium; it left a less insoluble residuum than Eastern opium, and he procured more morphia from it than from Smyrna opium. In an experiment on about two ounces of each, he obtained about 10·38 per cent from the former, and only 7·08 per cent. from the latter. It contained no narcotina. The disappearance of one principle (narcotina), and the augmentation of another (morphia), caused by climate, are interesting and important facts. Petit[||] got from 16 to 18 per cent. of morphia; and Caventou obtained from 22 to 28 per cent. from French opium; but in the latter case the morphia was probably very impure.

GERMAN OPIUM.—This opium, when obtained from the Papaver somniferum (*a*) *nigrum*, furnished under the analysis of Blitz, of Erfurt, from 16½ to 20 per cent. of morphia, and from 6¼ to 9½ of narcotina; while from that produced by the P. somniferum (*b*) album, and on which he procured conversely 6·8 per cent. of morphia, and 33 per cent. of narcotina.

ON THE ADULTERATIONS OF OPIUM.

Opium, like most other articles of a costly character, is subjected to considerable and varied adulteration, as proved by the concurrent testimony of nearly all writers on this important drug, and as well by the results of the analyses of numerous samples.

"The first sophistication," says Dr. Pereira, "which opium receives, is that practised by the peasants who collect it, and who lightly scrape the *epidermis* from the shells or capsules to augment the weight. This operation adds about one-twelfth of foreign matters." In further proof of the practice of this adulteration, we have likewise the authority of Mr. Impey, who states: "It is during the operation of scraping that the first sophistication occurs, the scraper being carried heavily over the capsule, taking with it a considerable part of the beard or pubescence."

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[*] Trans. Soc. Arts, xliii. 67.

[†] Ibid. l. 25.

[‡] Duncan, Suppl. to the Ed. Disp. p. 81.

[§] Journ. de Pharm., xxi. 570.

[||] Ibid. xiii. 183.

According to Dr. Eatwell, whose Report on Indian opium we have already referred to, "the grosser impurities usually mixed with the drug, to increase its weight, are *mud*, *sand*, *powdered charcoal*, *soot*, *cow-dung*, pounded *poppy petals*, and pounded *seeds* of various descriptions. All of these substances are readily discoverable in breaking up the drug in cold water, removing the soluble and lighter portions of the diffused mass by decantation, and carefully examining the sediment. By this means, impurities of the above nature usually become physically apparent. *Flour* is a very favourite article of adulteration, but is readily detected. Opium so adulterated speedily becomes sour; it breaks with a peculiar short, ragged fracture, the sharp edges of which are dull, and not pink and translucent as they should be; and, on squeezing a mass of the drug after immersion in water, the starch may be seen oozing from its surface. The application of the iodine test, however, furnishes conclusive evidence of its presence, or at least of that of some amylaceous compound. The farina of the boiled *potato* is not unfrequently made use of; ghee and goor (an impure *treacle*) are also occasionally used, as being articles at the command of most of the cultivators. Their presence is revealed by the peculiar odour and consistence which they impart to the drug. In addition to the above, a variety of *vegetable juices*, *extracts*, *pulps*, and *colouring matters* are occasionally fraudulently mixed with the opium, such as the inspissated juice of the common *prickly pear* (*Cactus dilenii*), the extracts prepared from the *tobacco plant* (*Nicotiana tabacum*), the *Datura stramonium*, and the *Indian hemp* (*Cannabis indica*), &c. The gummy exudations from various plants are frequently used; and of pulps, the most frequently employed are those of the *tamarind*, and of the *Bael fruit* (*Ægle marmelos*). To impart colour to the drug, various substances are employed, as *catechu*, *turmeric*, the powdered flowers of the *mowha tree* (*Bassia latifolia*), &c."

"From one sample of Smyrna opium," writes Dr. Pereira, "weighing ten ounces, I obtained ten drachms of stones and gravel." Speaking of Egyptian opium, Dr. Pereira writes:— "Some very inferior qualities are sometimes offered for sale, which appear to the sight and touch to be largely adulterated." And further on, the same author goes on to state:—"Opium is brought into the market of unequal degrees of purity, in consequence of its having been subjected to adulteration, and partly perhaps from the employment of different methods of preparation. Furthermore, opium from which the morphia has been extracted has been fraudulently introduced into commerce."*

Landerer† has described an adulteration of a sample of opium obtained direct from Smyrna, which he discovered in the preparation of a tincture. After several hours' digestion, the tincture assumed a slimy or mucilaginous condition, and in the course of a few days became so gelatiniform, that it could not be poured out from the glass; by a careful examination, *salep powder* in large proportion was discovered in the opium; and Landerer was afterwards informed that this is a very common adulteration, practised in order to make the opium harder, and to hasten the process of drying. Dr. Pereira also speaks of an opium which contained a gelatiniform substance‡; and Mr. Morson has met with an opium, in which an apparently similar substance was present.§ Landerer also states, that the extract obtained by boiling the poppy plants is commonly added to Smyrna opium.‖

In Dr. Normandy's work ("Commercial Handbook of Chemical Analysis") we meet with the following statements relating to the adulteration of this drug: "Opium is often met with in commerce from which the morphine has been extracted; on the other hand, this valuable drug is often found adulterated with *starch*, *water*, *Spanish liquorice*, *lactucarium*, *extract of poppy leaves*, *of glaucium luteum*, *and other vegetable extracts*, *mucilage of gum tragacanth*, *or other gums*, *clay*, *sand*, *gravel*; often the opium is mixed in Asia and Egypt, when fresh and soft, with finely-bruised grapes from which the stones have been removed; sometimes, also, a mixture, fabricated by bruising the exterior skins of the capsules and stalks of the poppy, together with the white of eggs, in a stone mortar, is added in certain proportions to the opium. In fact, this most valuable drug, certainly one of the most important and most frequently used in medicine, is also one of the most extensively adulterated."

It is abundantly shown by the foregoing quotations and extracts, that *gum opium* is very extensively adulterated; it does not appear, however, that any observations have yet been made respecting the adulteration of *powdered opium*; whether, for instance, like so many other vegetable powders, it is subjected to sophistication in the process of grinding.

The majority of observations found in works treating of adulteration are nearly all of a general character, and fail to show the condition as to purity of the articles as they actually reach the consumer; the great object of these inquiries is to supply this chief defect in our existing information, a work, in many cases, of extreme labour and difficulty, but it is upon this feature that the value and interest of these articles mainly depend. We thus ascertain what are the common and prevailing adulterations, what the more uncommon and rare, and lastly, we are enabled to reject a whole host of substances and materials from the list of alleged sophistications.

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* Journ. de Pharm., xxiv. 325. 446.; xxv. 297.; also Journ. de Chim. Méd. iv., 2nde Sér., pp. 335. 432.

† Buchner's Repertorium, bd. vi., heft 3., p. 349.

‡ Elements of Materia Medica, vol. ii. p. 1742. Second Edition.

§ Pharm. Journ., vol. iv. p. 503.

‖ Archiv. der Pharm., September, 1850, p. 293.

We will now proceed to give the results of the analysis of *Twenty-three samples* of the principal kinds of *Gum Opium* in the state in which it is imported into this country. These were—

That out of the *Twenty-three* samples of gum opium analysed, *nineteen* were adulterated, and four only genuine, many of these, as shown by the microscope, being adulterated to a large extent; the prevailing adulterations being with POPPY CAPSULE and WHEAT FLOUR.

That the amount of ALKALOIDS varied from 2·7 to 14·0 per cent., or in the proportion of nearly one to five; that is, some of the samples were five times as strong as others. This variation of strength is partly due, no doubt, to the adulteration to which so many of the samples were subjected, but partly also to the varying activity of the opium, determined by natural causes, such as differences of soil, climate, and mode of preparation.

The above analyses, therefore, incontestably prove that opium, in the state in which it is imported into this country, is very extensively and commonly adulterated.

Looking at the results of the *chemical* analyses of the opium we perceive that the different samples vary in the most remarkable manner in their composition. To such an extent is this the case that one would, in several instances, be led to suspect the fact of adulteration from the chemical analyses alone, without, however, being able positively to affirm its existence, in consequence of the degree to which, in extreme cases, the composition of gum opium of undoubted purity is itself found to vary. Making all due allowance for such variation, however, we are still enabled to indicate, in addition to those already enumerated as being adulterated with poppy capsule and wheat flour, as undoubtedly adulterated, two samples of Smyrna opium, and two of Egyptian opium, which were adulterated with *sand*,, *sugar*, and *gum*.

From the analyses instituted of *Forty samples* of *powdered opium* it appeared:—

That *Thirty-one* of the samples were adulterated, and *one* only genuine; the principal adulterations, as in the previous case, being with POPPY CAPSULE and WHEAT FLOUR.

That *four* of the samples were further adulterated by the addition of POWDERED WOOD, introduced no doubt in the process of grinding

That the amount of *alkaloids* varied from 2·3 up to 12·2 per cent., or in the proportion of nearly one to six—that is, the samples differed in strength in that ratio. The lowest amounts of alkaloids furnished by the powdered opiums were 2·3 and 3·2 per cent.; these were, in all probability, exhausted opiums, which had been previously employed in the preparation of tincture.

We believe that it is not an unfrequent practice with druggists to employ the insoluble residue, when dried and pulverised, left from the preparation of the tincture of opium, in the adulteration of powdered opium. We have also known it to be used for making the unguentum gallæ compositum.

"I have known," states Dr. Thomson, in his evidence before the Parliamentary Committee, "extract of opium mixed with extract of senna, and from 30 to 60 per cent. of water."

From all this, then, it follows, partly in consequence of adulteration, that crude opium varies to a great extent in strength and activity, so much so that no certain reliance can be placed on the effects produced by this remedy, administered according to any fixed or uniform scale of doses.

It further follows that all those preparations made from opium, or into the composition of which opium enters, are of equally uncertain strength and power — as *tinctura opii*, *tinct. camphoræ composita*, *vinum opii*, *pulvis cretæ comp. cum opio*, *pulv. ipecacuanhæ comp.*, *pulv. kino comp.*, *pilulæ saponis comp.*, *confectio opii*, *extractum opii*, *enema opii*, *linimentum opii*, and *emplastrum opii*, of the London Pharmacopœia; *tinctura opii ammoniata*, *acetum opii*, *pilulæ opii*, *pil. calomelanos et opii*, *pil. plumbi opiatæ*, *electuarium opii*, and *trochisci opii*, of the Edinburgh and Dublin Pharmacopœias.

The fact that even *genuine* gum opium is possessed of very different degrees of strength, has been clearly shown by various analysts and experimentalists: —

Chevallier found in six samples of choice Smyrna opium the following proportions of water — viz., 33·5, 35·0, 40·5, 42·25, 52·5, and 53·0 per cent.

O'Shaughnessy found from 25 to 21 per cent. of water in Indian opium (Behar agency), and 13 per cent. in Patna opium. Dr. Eatwell, the opium examiner in the Benares district, finds that the proportion of water varies from 30 to 24·5 per cent. in the opium of that district.

With respect to the proportion of morphia, Chevallier states that Smyrna opium contains from 5·6 to 6·4 per cent. of that alkaloid; Constantinople opium, from 2·8 to 3·2; and Egyptian opium, from 2·0 to 2·4 per cent.

The subject of the strength of opium was discussed at the Pharmaceutical Society of Paris on the 2nd of April, 1850. Mialhe stated that the proportion of morphia in commercial opium varied from 1 to 10 per cent., and this was confirmed by Soubeiran. Guibourt said he obtained from 15 to 17 per cent. from Smyrna opium, as also did MM. Caventou and Aubergier. Dublanc affirmed that it contains at most 14 per cent., but sometimes it is even as low as 1, 2, or 3 per cent. Guillemette rarely obtained more than 14, while good specimens yielded from 10 to 12 per cent. De Vry analysed 21 samples of commercial opium, and found the proportions of morphia to vary from mere traces to 9·2 per cent. (but his process was not a good one). Reich got from 10 to 12 per cent.; and O'Shaughnessy obtained from the opium of the Behar agency from 1·75 to 3·5 per cent. of morphia, and 0·75 to 3·5 of narcotina; in that from Hazareebaugh, 4·5 of morphia, and 4·0 per cent. of narcotina; and in Patna garden opium he extracted 10·5 per cent. of morphia, and 6·0 per cent. of narcotina. Dr. Eatwell found in the opium of the Benares district the following proportions of morphia and narcotina, in the years 1845 to 1848:—

	Morphia.	Narcotina.
1845	2·48	5·26
1846	2·38	4·52
1847	2·20	5·68
1848	3·21	4·06

These facts show that, even if we could succeed in obtaining, in all cases, gum opium of undoubted purity, yet we could not rely upon its producing uniform effects. This consideration shows therefore the necessity of employing in medicine preparations made from this drug, of ascertained strength; these, to some extent, we possess in the salts of morphia; and no doubt it is far better to prescribe these, in the majority of cases, in preference to crude opium.

But it is probable that a preparation might be obtained formed of more than one constituent of opium, and which would, therefore, more nearly resemble the complex and original drug. One method by which an approximation to uniformity of strength could be obtained in the tincture of opium, is by a previous analysis of the gum opium, from which it is to be prepared, and a regulation of the dose according to the strength of that opium; or the alkaloids might be added where they were deficient, so as to ensure as near an approach to uniformity as practicable.

It should be observed that, of the samples of powdered opium, the results of the examination of which have just been given, those which were found to contain the largest per-centages of water had been kept in a tin case, and thus the moisture prevented from escaping; while most of the samples which contained the smaller per-centages of water, had been exposed to the atmosphere, and so had lost part of their water.

In reference to the varying quantity of moisture contained in opium, we find the following remarks by Mr. C. V. Hagner, of Philadelphia:*—

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* Pharmaceutical Journal, Sept. 1. 1851, vol. ix. p. 124.

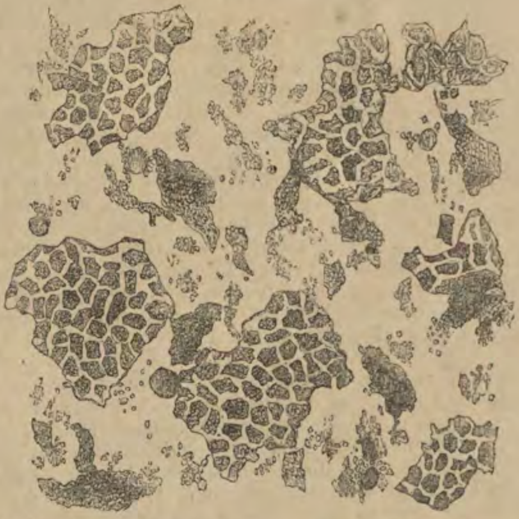
"We sometimes receive vegetable substances, roots, barks, gums, &c., direct from the hold of a ship, or from damp cellars; at other times we receive the same articles from the garret of a store, where they may have been for a year or more. It is ridiculous to expect the same loss in both cases. Most of the articles we powder contain more or less water, which we are obliged to dry out, and if we did not dry them artificially when we reduced them to such minute particles as constitute a fine powder, the water would in a great measure escape by evaporation. This constitutes the loss in powdering drugs; at least the great amount of it. Some time back, I received a large lot of bayberry bark from a house in this city, who had bought it without sufficient examination, for it had been completely saturated with water, purposely, I suppose, by some 'financier' to increase the weight. When I opened it, and saw the condition it was in, I called the attention of the owner to it, but he had unfortunately already paid for it. I dried it, and it lost over thirty-five per cent. in the drying alone. Now what a position I would have been in, had I been restricted to a loss of two or three per cent. It would have taken a considerable quantity of what Mr. Redwood facetiously calls 'veritable powder of post' (sawdust) to have made this matter straight.

"Twenty years back, I attempted to unite to my other operations that of chipping and drying dye-woods, and ground in all from fifteen to twenty tons for different parties; and although the wood appeared to be dry, it lost over two hundred pounds on each ton, caused by evaporation on being cut into fine chips across the grain of the wood. Of course I received the usual amount of 'rowing up' for making such losses; so much so that I became heartily sick of the business, and sold at half the cost, the apparatus I had erected.

"It is customary to remedy this difficulty, not with 'powder of post,' but '*aqua font.*' Under the pretence that it improves the quality, water is freely used, not only to make good the loss, but a little further, and the consumer is made to pay a pretty high price for water. I have seen barrels of chipped wood that have laid some time in a store, fall short from fifteen to twenty pounds on the market weight. I think it is a fraudulent and useless custom. If the article is really improved by the operation (which I very much doubt), there is plenty of water in every dye-house; let the consumer water it as much as he chooses—let the dealer sell him wood, not water, and charge accordingly, and let the chipper be a 'hewer of wood;' but have some compassion on him, and do not also make him a 'drawer of water.'

"The important article of opium comes to us in very different conditions. I believe it is the general custom of the druggists to keep this article in their cellars to prevent its drying and losing weight; some, however, do not, particularly when it is intended to be powdered; of course the loss in the former must necessarily be greater than in the latter instance, and it would be perfectly unreasonable, under such circumstances, to bind the powderer to a regular percentage of loss in powdering opium. I have been informed, and I believe correctly, that there exists in some other places a conventional rule of six per cent. in powdering opium ; so far as I remember, I rarely, if ever, powdered it at a less loss than eight per cent., and sometimes as great as twenty per cent. I have examined my books in reference to the last twelve lots of opium powdered, and find they amount to 165 lbs. 12 oz. received, and 142 lbs. 2 oz. returned ; the least loss eight per cent., and the greatest near twenty per cent., the average being 14 lbs. 5 oz. per cent. Mr. Redwood gives the average loss in powdering this article in London at 14 lbs. 14 oz. on the 112 lbs., the greatest eighteen, and the least six per cent.

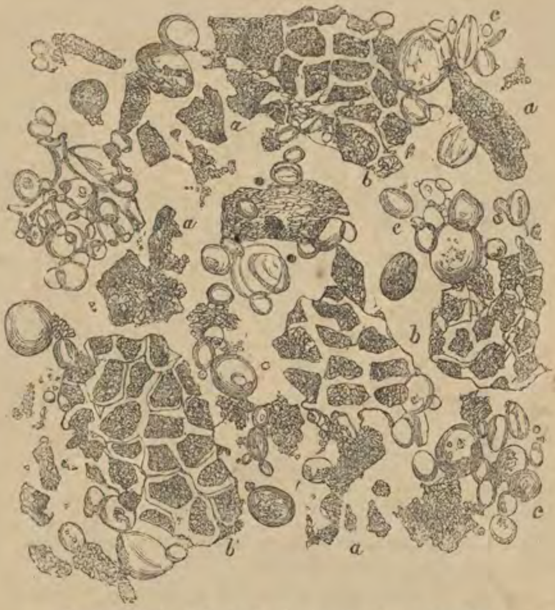
Fig. 205.



Sample of OPIUM adulterated with *poppy capsule*. Magnified 100 diameters.

"It would be a very easy matter for any druggist to ascertain the loss in drying any particular lot of opium, by cutting a portion into very small pieces, and drying it sufficiently to make a *fine* powder. Yet, notwithstanding this simple method of ascertaining the fact, I have met with instances (not many, to be sure, and none lately) where persons have sent their opium elsewhere to be powdered, for no other reason than that of the loss being less than I made. Perhaps I might have satisfied them had I made use of the 'powder of post,' or something else, which is, and must be done by every one who powders ordinary opium at a loss of only six per cent. This, however, I never have done, and never will do. I do not profess more honesty than my neighbours; but if I had no scruples on the subject, I can imagine a case where I might make myself amenable to justice as a participant in causing the death of a fellow being, whose life might be lost for the want of a proper article being administered. I repeat, if there were no other motives, I would not, under any circumstances, make myself liable to such a charge. Opium is one of the most important of the drugs that pass through my hands. Every physician, druggist, and apothecary, knows the importance of having it right, and, so far as it depends on me, it shall be right, be the loss in powdering what it may.

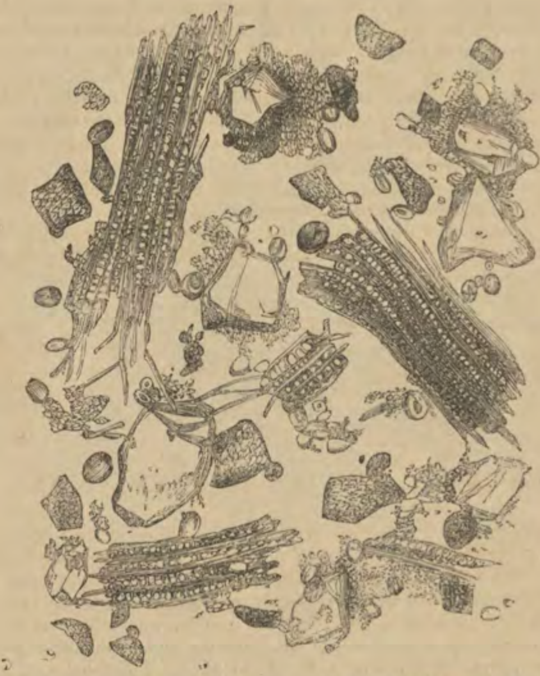
Fig. 206.



Sample of Opium adulterated with *poppy capsule* and *wheat flour*. Magnified 220 diameters.

"With a conventional loss of six per cent. there can be no uniformity in the article. A powderer receives a lot of opium so dry that it only loses six per cent. in powdering. He receives another lot that loses twenty per cent. To bring the loss on the latter to the same as the former, he must put in fourteen per cent. of adulteration, and then you have one article fourteen per cent. less in efficiency than the other. From some cause unknown to me, the consumption of powdered opium has greatly increased in the last five years, and seems to be increasing annually, if I may judge from the quantities I powder."

Fig. 207.



EGYPTIAN OPIUM, adulterated with *gum*, *woody fibre*, and a little *wheat flour*. Magnified 100 diameters.

On the Detection of the Adulterations of Opium.

The adulterations of gum and powdered opium with *poppy capsule* (*fig.* 205.), *wheat flour* (*fig.* 206.), or *other vegetable substances*, may be readily discovered by simply examining a minute portion of the opium under the microscope. To estimate the quantities of these present, a dried and weighed amount of the opium must be dissolved in water, the insoluble residue being dried and weighed.

Sand or *other insoluble inorganic substance* which may be present may be discovered, and its amount calculated in the same manner.

The *gum* may be calculated from the residue of the filtered watery extract which is insoluble in alcohol.

Lastly, it is well in most cases to determine the amount of *alkaloids* present by the processes already described.

Customs' duty on Opium, 1*s.* per lb. Quantities retained for home consumption were, in 1854, 61,432 lbs.; in 1855, 56,067 lbs.; in nine months of 1856, 35,354 lbs.

SCAMMONY, AND ITS ADULTERATIONS.

The adulterations discovered in drugs, like those in food, are practised by three different classes of persons — the preparers or manufacturers, the wholesale and the retail dealers. In some cases the adulterations detected are exclusively the work of one or other of these classes; in others, each does its part in the deterioration and sophistication. In the course of our investigations we have met with many examples proving the truth of the above classification, and the article scammony affords an illustration in point.

Scammony is the gum resinous exudation obtained by incisions into the roots of *Convolvulus scammonia.* The roots are perennial, tuberous, tapering, three or four feet long, and contain an acrid, milky juice, which, dried, constitutes scammony. It grows in hedges and bushy places in Greece and the Levant.

Scammony was known to the ancient Greeks. Dioscorides thus, according to Pereira, describes the mode of procuring it: —

"The head being separated, the root is to be excavated in the form of a dome, or vault, by a knife, so that the juice may flow into the cavity, from which it is to be taken out in shells. Others excavate the earth, and having incised the root, let the juice run into the cavity, which has been previously lined with walnut leaves. When the scammony is dry it is removed."

In 1776, the method of procuring scammony adopted, and which is probably that followed in the present day, was, according to Dr. Russel*, as follows:—

The earth being cleared away from the upper part of the roots, the peasants cut off the tops obliquely about two inches below where the stalks are given off. Under the most depending part of each incision a shell, or other suitable receptacle, is placed, into which the juice slowly flows. The shell is left for about twelve hours, when the whole of the juice has exuded. The quantity yielded by each root does not exceed a few drachms. The milky juice from the several roots is put together, often into the leg of an old boot, where it gradually becomes hardened, and forms scammony.

Scammony is usually imported from Smyrna. Occasionally it comes by way of Trieste, and still more rarely it is brought from Alexandretta, the port of, and road to, Aleppo. It comes over in boxes and drums, which are frequently lined with tin.

The different kinds of scammony of commerce are arranged by Dr. Pereira under three heads—*pure*, *adulterated*, and *factitious*.

The pure scammonies are— *Virgin Scammony*, the only pure kind known in English commerce; scammony in calabashes or shells, and probably Trebizond or Samos scammony, which differs very much in appearance from ordinary scammony. Virgin scammony occurs usually in irregular pieces, covered with a whitish grey powder, which effervesces on the addition of a strong acid, showing that the pieces have been rolled in chalk; it is friable, the fractured surfaces being resinous, shining, and greenish black; they present small air cavities, and, examined with a magnifying glass, numerous grey, semi-transparent splinters or fragments are seen; the powder, viewed with a quarter-inch object glass, is observed to consist of numerous angular and resinous fragments of a greyish brown colour and of variable size (*fig.* 208.); intermixed with these other fragments sometimes occur, which are blackish or even quite black: these are best seen when the powdered scammony is viewed as an opaque object. It has been suggested by Dr. Russel that this difference is the result of different methods of drying, an explanation which is certainly not correct.

The black pieces in question undoubtedly consist of broken masses of vegetable tissue, infiltrated with the resin, as may be shown by the action of sulphuric ether, which, by dissolving out the resin, reveals the tissue. Although even the best scammony usually contains a small number of these fragments, yet we have observed that they are most abundant in the inferior or adulterated sorts In the residue left, after the removal of the resin by sulphuric ether, considerable quantities of vegetable tissue, cellular tissue, woody fibre, fragments of spiral vessels, and stellate cells, may frequently be detected by the microscope.

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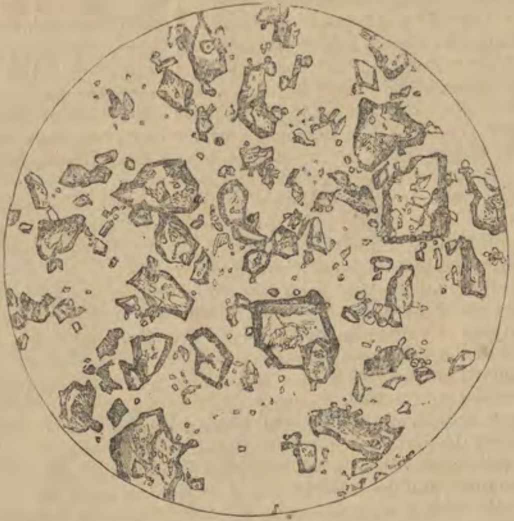
* Med. Obs. and Inq. vol. i. p. 13.

Fig. 208.



Pure or VIRGIN SCAMMONY in powder. Magnified 100 diameters.

Characters and Composition of Scammony.

With water, or saliva, scammony yields a milky fluid; it readily takes fire, and burns with a yellowish flame, leaving a minute portion of ash only when incinerated in a crucible—rarely exceeding three per cent. Its odour has been compared to old cheese; its taste is slight at first, but afterwards acrid; it is not rendered blue by iodine, nor does it effervesce with hydrochloric acid. Sulphuric ether should separate not less than 78 per cent. of extract, consisting principally of resin. Paper, wetted with an etherial or alcoholic solution of scammony, should undergo no change of colour when exposed to the orange fumes of nitric acid.

The following are the results of the analyses of three samples of scammony by Dr. Christison:*—

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* Dispensatory.

Pure Scammony.

	Old.	Old.	Moist.
Resin - - -	81·8	83·0	77·0
Gum - - -	6·0	8·0	6·0
Starch (fecula) - -	1·0	—	—
Lignin and sand - -	3·5	3·2	5·0
Water - - -	7·7	7·2	12·6
	100·0	100·0	100·0

On the Adulterations of Scammony.

Scammony, being a costly drug, is liable to great and varied adulteration; large quantities of *chalk* or *starch*, either separately or combined, are frequently mixed with it; sometimes it is adulterated with inferior and cheaper *resins*, as those of *guaiacum* and *jalap*; more rarely *dextrine*, *gum tragacanth*, *bassorin*; *sand* and *sulphate of lime*, or *plaster of Paris*, as well as some other articles, have been discovered in scammony.

Dioscorides states that Syrian scammony is adulterated with *euphorbia*, or *spurge*, and the meal of the *ervil*, or *bastard lentil* (*Errum ervilia*, Linn.).

Occasionally samples are met with professing to be scammony, which do not contain a particle of that drug, or small proportions only, and which being expressly made and compounded, in imitation of scammony, with a variety of ingredients, including even *wood* and *ivory-black*, are called *factitious*.

In Pereira's "Materia Medica" we meet with the following information in reference to the rarer kinds of adulterations which have been detected by different observers, the ordinary adulterations being those with chalk and starch.

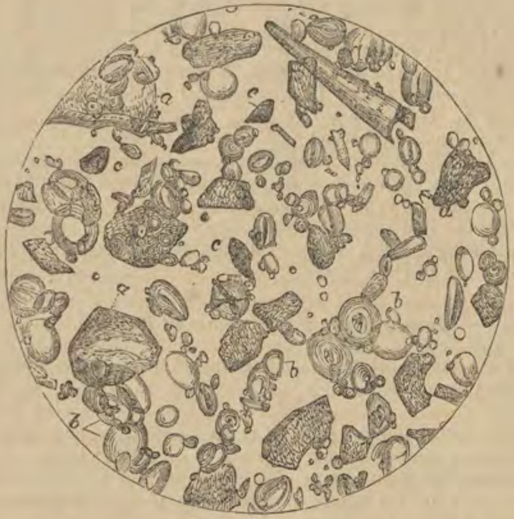
"*Calcareo-dextrinous Scammony.*—This sort differs in the circumstance that iodine produces a reddish-purple tint when added to the filtered decoction after it has become cold. It appears to contain carbonate of lime and dextrine.

"*Selenitic or Gypseous Scammony.*—This kind has been described by Marquart. Its specific gravity was 1·731, and it contained no less than fifty-two per cent. of gypsum (sulphate of lime.)

"*Bassorin Scammony.*—Marquart met with a scammony which had a horny consistence, and a specific gravity of 1·167. After it had been deprived of its resin and extractive, it swelled up in boiling water. The constituent which thus swelled up was soluble in caustic potash. Marquart regarded it as bassorin. In the Museum of the

Pharmaceutical Society is a specimen of scammony which is supposed to be adulterated with tragacanth and some resin.

Fig. 209.



SCAMMONY, largely adulterated with *wheat*, and probably *lentil* flowers. *a a*, broken fragments of scammony; *b b*, starch corpuscles of wheat; *c c*, black fragments of cellular tissue. Magnified 220 diameters.

"*Indian Scammony.*—From my friend Dr. Royle I have received a sample of scammony met with in the Indian bazaars. It is light, porous, of a greenish-grey colour; gritty under the teeth, as if containing a considerable quantity of sand, and having a balsamic, olibanum-like odour.

"*Factitious Scammony.*—To this division belongs part of the so-called *Smyrna scammony* of continental commerce, as well as *French* or *Montpellier scammony*. I have met with three samples of factitious scammony.

"Under the name *Smyrna scammony*, I purchased of a London dealer a sort of scammony in the form of circular, flat cakes, about half an inch thick. It is blackish, and has, externally, a slatty appearance; it breaks with difficulty; its fracture is dull and black; its specific gravity is 1·412. Moistened and rubbed, it evolves the smell of guaiacum. Boiled with water, it yields a turbid liquor (which is not rendered blue by iodine), and deposits a blackish powder; the latter, boiled with alcohol, yields a solution, which becomes greenish-blue on the addition of nitric acid, showing the presence of guaiacum.

"It is probably the *common Smyrna scammony* (Scammonium Smyrnense factitium) of Gray, who directs it to be made with Aleppo scammony, one pound; extract of jalap, five pounds; guaiacum resin, ten pounds; sago, ten pounds; and ivory-black, four pounds.

"Under the name of *Scammonium Smyrnense medicinale venale*, M. Batka has presented to the Pharmaceutical Society a spurious scammony, said to be made up of gum, bread, scammony, guaiacum, benzoin, wax, sand, and wood.

"*French* or *Montpellier Scammony* (*Scammonium Gallicum seu Monspeliacum*). This substance is made in the southern parts of France, with the expressed juice of *Cynanchum Monspeliacum*, mixed with different resins and other purgative substances. It occurs in semi-circular, blackish, hard, compact cakes, which frequently have the smell of balsam of Peru."

Results of the Examinations of Samples.

The following conclusions were deduced from an examination of *Thirty* samples of Scammony, as imported, as vended, and as sold in powder.

That out of the *thirteen* samples of *Resin of Scammony* as imported, submitted to examination, *one* only was *genuine;* it yielding 79·60 per cent. of resin, the active principle.

That *eleven* of the samples were more or less *adulterated;* the amount of adulteration varying between 8 and 75 per cent., and the proportion of resin between 13·20 and 72·00 per cent.

That *one* sample was entirely *factitious*, being composed of the resins of *guaiacum* and *jalap*, with much *woody fibre, cellular tissue*, and other *insoluble matter.*

That the adulterating ingredients detected, consisted, for the most part, of *carbonate of lime* or *chalk*, and *wheat flour*, with sometimes *sand*, or other *earthy substance*, *gum*, and considerable quantities of *woody fibre* and *cellular tissue.*

That of the *seventeen* samples of *Powdered Scammony*, purchased of various chemists and druggists, analysed, *one* only was *genuine*, it affording 76·40 per cent. of resin.

That the *whole* of the remaining samples were *adulterated*, frequently to an enormous extent; the adulterating ingredients constituting from 18 to 65 per cent. of the entire article, and the resin varying from 27·20 to 65 60 per cent.—that is to say, some of the samples contained little more than one fourth the proper quantity of scammony, and of course were deficient to that extent of the active properties which they should possess.

That the adulterating ingredients in these samples consisted principally of enormous quantities of *wheat flour*, with frequently much *chalk*, and occasionally *sand* or other *earthy substances*.

Mr. Herring, speaking of the adulteration of scammony, states in his evidence before the Parliamentary Committee, "We have some imported which has contained from 80 to 90 per cent. of chalk." Mr. Herring also states that there is ten or twenty times as great demand for the spurious and cheaper article as for the other. The price in the market, he observes, is one great criterion of purity; scammony varies from 5*s* to 40*s*. per lb., and opium from 9*s*. to 20*s*. per lb.

We have now to ascertain who are the parties that practise these adulterations.

From the fact that the majority of the samples of gum resin of scammony, as imported, contain chalk, and sometimes wheat flour, &c., it is evident that these adulterations are practised, to some extent, before the article is brought into the English market. In reference to this point, we meet with the following information in Pereira's "Materia Medica":—

"Of this entirely pure scammony, says Dr. Russel, but very little is brought to market, the greater part of what is to be met with being adulterated, if not by those who gather it, by those who buy it of them abroad; for the chief part of what is brought hither passes through the hands of a few people, chiefly Jews, who make it their business to go to the villages of any note near which the scammony is collected (as Antioch, Shogre, Elib, Maraash, &c.), and there buying it while it is yet soft, they have an opportunity of mixing with it such other things as suit their purpose best—as wheat flour, ashes, or fine sand, all of which he found it mixed with. But there seems," he adds, "some other ingredient (possibly the expressed juice), which makes it so very hard and indissoluble that he was not able to discover it to his satisfaction.

"I have been informed by a Turkey merchant, who formerly resided at Smyrna, that scammony is brought into Smyrna in the soft state on camels. Here it is mixed with various impurities by persons (Jews) who are denominated scammony makers, and who adulterate it, and thereby lower its value to suit the market."

It is equally evident, from the analyses given, that scammony undergoes further adulteration after its arrival in this country—this consisting principally in the addition to it of large quantities of wheat flour.

We may here observe that in some cases it is quite possible to determine whether the addition of the flour has been made subsequent to its importation or not by the condition of the starch granules. When starch is added to scammony abroad, it is mixed with it while the resin is soft; the granules thus become embedded in and coated with the resin in a manner from which no subsequent powdering can entirely free them.

On the other hand, when the starch has been added after the resin has been reduced to powder, the granules and masses of granules retain their usual appearance and characters.

The facts brought out in this article are calculated to give rise to some serious reflections; for if adulterations exist in other important articles of the Materia Medica to anything like the same extent, then there is introduced into the treatment of diseases endless uncertainties and differences through the varying strength and action of remedies.

The proper doses of remedies are usually determined by the results of repeated and carefully conducted experiments with drugs and chemicals of ascertained purity. These results are recognised and acted upon by the profession at large; but what, in the face of such facts as are referred to in this and the preceding article, is the practical value of such results? for we see that the strength of the same remedy, from adulteration only, sometimes varies as one to four—that is, forty grains in some cases will not be stronger than ten of the genuine drug. No wonder, then, that the physician is so often disappointed in the effects produced by his prescription, and that the patient even should sometimes look with distrust on his medical adviser, whose statements and expectations, with respect to the action of his remedies, so frequently fail to be realised.

Here, too, we meet with an explanation of the extraordinary doses in which certain remedies are reported to be used by different practitioners; some telling us that they prescribe enormous doses of calomel, elaterium, opium, scammony, &c., and find only the ordinary effects; hence, such physicians are led to conclude that the remedy is not so active as described, overlooking in general the existence of adulteration, and are even induced to entertain serious doubts with respect to the general efficacy of medicine. Under such circumstances, it is useless for the physician to consider carefully the age, strength, and condition of his patient for the purpose of apportioning correctly the doses of the remedies contained in his prescription; too often the adulterator steps in and renders all attempt at calculation futile.

Neither with safety can the prescriber venture to act on the presumption that certain medicines, being ordinarily adulterated, may be administered in more than the recognised doses, for as it is just possible that he may secure a genuine article, as great an error would be committed, perhaps, by such a proceeding, as by an adherence to the usual practice.

The gum resin and powder of scammony being so extensively adulterated, it of course follows that all the other articles of the Materia Medica, into the composition of which scammony enters, as *confection of scammony*, *scammony with calomel*, and *compound scammony powder*, are similarly adulterated, their properties and strength being thus rendered very uncertain.

On the Detection of the Adulterations of Scammony.

The adulterations most frequently practised, and the detection of which is therefore most important, are those by *chalk*, *sand*, *starch*, *guaiacum*, and *jalap*.

The chalk may be detected by the effervescence occasioned on the addition of acetic or hydrochloric acid. The disengagement of the carbonic acid is well seen in minute quantities of the powdered scammony, wetted with the acid, and watched under the microscope with an inch or half-inch object glass. The per-centage of chalk contained in any sample may be determined in several ways. Chalk, well incinerated at a red heat, especially in combination with organic matter, is reduced to caustic lime. The ash of well burned scammony, adulterated with chalk, must therefore be brought back into carbonate of lime, 100 parts of which consist of 56·29 of lime, and 43·71 of carbonic acid. The lime contained in the scammony, when incinerated, may be moistened with a drop or two of a saturated solution of carbonate of ammonia, and again ignited just below redness, by which means the caustic lime is converted into carbonate of lime, the ammonia being driven off; or, lastly, the partially decomposed carbonate of lime, previous to incineration, may be converted, by the addition of a little dilute sulphuric acid, into sulphate of lime, which is not decomposed by heat, and the carbonate calculated from it. When *sulphate of lime* is present, this must be dissolved in a small quantity of hydrochloric acid, and the sulphuric acid precipitated by means of cloride of barium or nitrate of baryta, and the lime by oxalate of ammonia, the precipitates being calculated for sulphate of lime.

If *sand* be present, it is in general sufficiently indicated by its insolubility in hydrochloric acid. Where sulphate of lime, sand, or other earthy matters, are employed separately, the weight of the ash sufficiently indicates the per-centage.

The *starch* is detected by the addition of iodine to the cold decoction; but it is only by the microscope that the kind of starch employed can be determined. The presence of *dextrine* is revealed either by the microscope or by iodine. *Guaiacum* is discovered by its smell, when rubbed down, or by a piece of paper moistened with the tincture becoming blue when exposed to nitrous acid fumes. *Jalap resin* is insoluble in ether and oil of turpentine; digested in a watch-glass, with oil of vitriol, a crimson coloured solution is obtained.

Scammony is free of duty, as are also all drugs unenumerated, and amongst them those treated of in the following articles, namely, jalap, ipecacuanha, rhubarb, colocynth, and squills.

JALAP, AND ITS ADULTERATIONS.

The true jalap, *Exogonium purga*, belongs to the natural order *Convolvulaceæ*, and is closely allied, both in its botanical relations and properties, to *Convolvulus scammonia.* It is a climbing plant, with branched, annual stems, and tuberous, perennial roots. It grows in the woods of Mexico, near Chicanquiaco, at an altitude of nearly 6000 feet above the level of the sea.

The part of the plant employed in medicine is the *tuber.* When recent, the tubers are irregularly ovate-conical, are covered by a thin, blackish epidermis, numerous rootlets or radicles springing from their lower surface; while internally they are fleshy, white, and obscurely laminated.

The dry tubers vary in size from a nut to an orange, the largest occasionally exceeding a pound in weight. When entire they are usually oval, the extremities being more or less prolonged or pointed; they are wrinkled, and covered by the blackish-brown epidermis. The larger tubers frequently exhibit several incisions, made for the purpose of facilitating their exsiccation. Internally, they present numerous concentric rings, arising from their laminated structure.

Tubers of good quality should be firm, solid, and heavy, and when broken, of a deep yellowish-grey colour, with a somewhat resinous fracture. When very light they are usually hollow, from defective trying; when white and friable, they contain excess of starch, and are of inferior quality. Sometimes the tubers are imported in slices, which appear to be quarter segments, according to Pereira, of transverse slices; this variety is occasionally called *spurious jalap*, or, from its shape, *cocked-hat jalap;* and like the tubers, when white and friable, the slices are inferior. The tubers are very liable to be attacked by worms; as these do not touch the resin, it is to be obtained from such tubers in normal quantity.

The only market for jalap is Jalapa, a town of Mexico, from which jalap takes its name, and from whence it is imported by way of Vera Cruz.

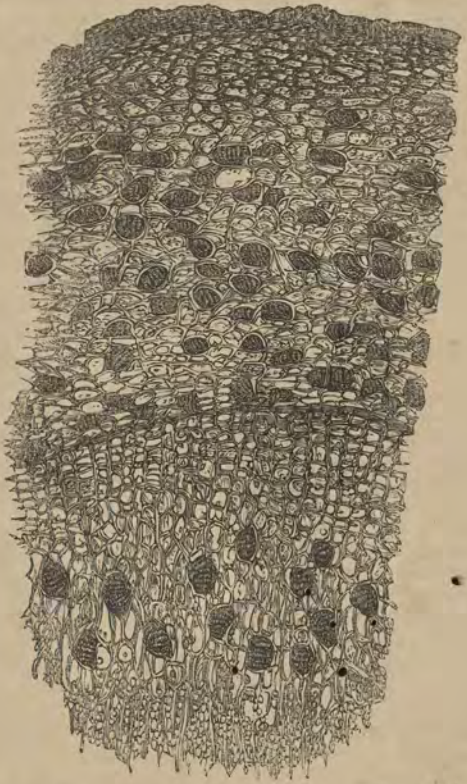
Structure of the Jalap Tuber.

The minute structure of the jalap tuber is very characteristic, and it is necessary that the observer should be thoroughly acquainted with it before he will be able to detect the adulterations to which jalap in powder is liable.

The epidermis does not differ materially from the same structure as it occurs in many other plants, it consisting of what we are in the habit of denominating stellate cells, of an elongated form. It is but seldom, however, that these cells can be detected in the dried tuber.

The lamellæ, viewed in transverse sections, are seen to be composed principally of cells, with, along the margins, occasional bundles of dotted vessels and woody fibre. The cells, of which the tuber itself is almost entirely composed, are not all of one kind. First, there are numerous, well-defined, dark, and somewhat angular cells lying here and there in the midst of the other cells. *Fig.* 210.

Fig. 210.



Transverse section of JALAP TUBER, showing the appearance and distribution of the dark, and probably *resin cells*. Magnified 30 diameters.

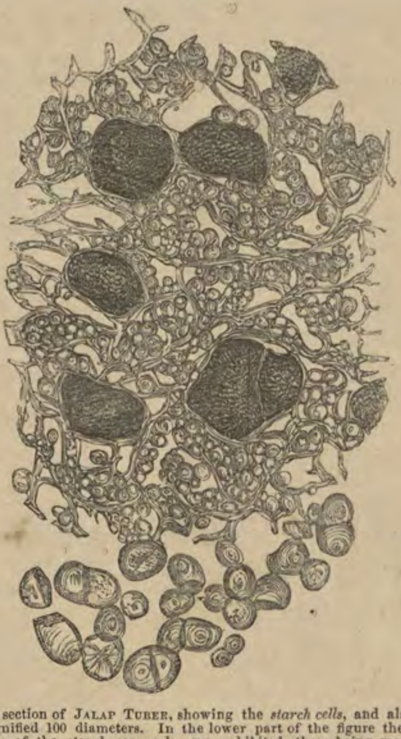
These cells appear to contain resin; but since they are slowly acted upon by water, so that from being dark and opaque they become clear and transparent, it is evident that they also contain some soluble substance.

Of the remaining cells, many are apparently empty; these constitute chiefly the outer lamellæ of the tuber. *Fig.* 210.

Lastly, other cells, crowded with starch corpuscles, occur in great abundance; the innermost layers of the tuber are chiefly composed of these cells. *Fig.* 211.

The resin cells are scattered throughout the whole of the tuber, occurring indifferently in the midst of either the apparently empty cells, or those filled with starch.

Fig. 211.

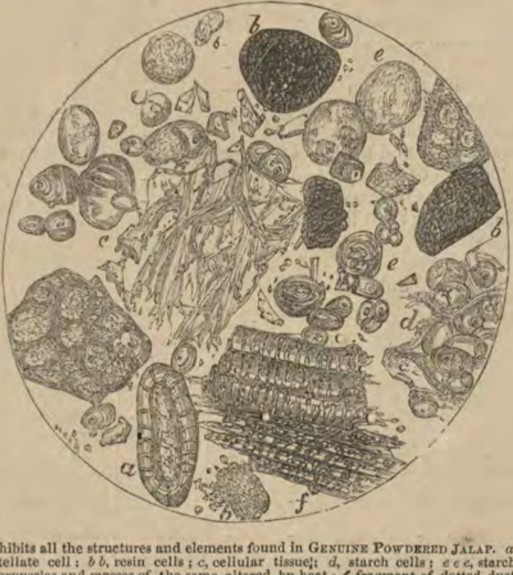


Transverse section of Jalap Tuber, showing the *starch cells*, and also the *resin cells*, magnified 100 diameters. In the lower part of the figure the form and characters of the *starch corpuscles* are exhibited, these being magnified 220 diameters.

The starch corpuscles are of considerable size, and possess well-marked characters. Some are circular, but somewhat flattened, while others are muller-shaped. These last are occasionally united in twos, threes, and fours; whenever muller-shaped starch corpuscles are met with in any vegetable tissue, it is to be understood that they were all originally united in this manner, and it is to such union that their form is chiefly due. They are all furnished with a distinct hilum, around which one or two concentric rings may sometimes be seen (*figs.* 211, 212.). Many of the corpuscles in every tuber have become expanded and misshapen from the heat employed in the process of drying.

In genuine powdered jalap all the structures above described may be detected: the stellate cells of the epidermis, the resin cells, the empty cells, those filled with starch, numerous free starch corpuscles, and occasional fragments of dotted vessels and woody fibre. The occurrence of single cells completely filled with starch corpuscles is very characteristic of powdered jalap.

Fig. 212.



Exhibits all the structures and elements found in GENUINE POWDERED JALAP. *a*, stellate cell; *b b*, resin cells; *c*, cellular tissue; *d*, starch cells; *e e e*, starch corpuscles and masses of the same altered by heat; *f*, fragment of dotted duct and woody fibre. Magnified 220 diameters.

It should be particularly remembered that the tuber of jalap is made up almost entirely of *cellular tissue*, with but few *dotted vessels*, and *extremely little woody fibre*, the fibres being large, coarse, and dotted, closely resembling, in fact, except in size, the ducts themselves.

Composition of Jalap.

The jalap tuber owes its activity as a purgative principally to the resin which it contains.

The following are some of the principal analyses of jalap which have as yet been made, that by Gerber being the most complete :

Gerber's Analysis. *

Hard resin	7·8
Soft resin	3·2
Slightly acrid extractive	17·9
Gummy extractive	14·4
Colouring matter	8·2
Uncrystallisable sugar	1·9
Gum, with some salts	15·6
Bassorin	3·2
Vegetable albumen	3·9
Starch	6·0
Water	4·8
Malic acid, and malates of potash and lime	2·4
Chlorides of calcium and potassium	1·4
Phosphates of magnesia and lime	1 7
Carbonate (?) of lime	3·0
Loss	4·6
Jalap	100·0

Henry's Analysis. †

	Light.	Sound.	Worm-eaten.
Resin	12	9·6	14·4
Extractive	15	28·0	25·0
Starch	19	20·4	20·6
Woody fibre	24	42·0	40·0
Jalap	100	100·0	100·0

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* Gmelin, Handb. d. Chemie, bd. ii. s. 1299.

† Bull. de Pharm. t. ii. p. 87.

Ledanois's Analysis. *

	Male, Light, or Fusiform Jalap.
Resin	8·0
Gummy extract	25·6
Starch	3·2
Albumen	2·4
Woody fibre	58·0
Water and loss	2·8
Jalap	100·0

Nees v. Esenbeck and Marquart's Analyses. †

	Root of Exogonium Purga.	Commercial Jalap.	False Jalap.
Extractive	20·416	27·50	6·66
Resin	12·083	13·33	18·33
Matters insoluble in alcohol	67·500	59·16	75·00
Jalap	100·000	100·00	100·00

Guibourt's Analysis.

	Officinal Jalap.	False rose-scented Jalap.
Resin	17·65	3·23
Liquid sugar by alcohol	19·00	16·47
Brown saccharine extract obtained by water	9·05	5·92
Gum	10·12	3·88
Starch	18·78	22·69
Woody fibre	21·60	46·00
Loss	3·80	1·81
Jalap	100·00	100·00

From the above analyses, some of which are not very complete, it is evident that the amount of resin found in jalap is subject to considerable variation; further analyses of the tuber, in different states, are still much needed.

It will be noticed that the woody fibre, in some of the analyses, is put down at a very high figure. The usual practice is to consider all matters not soluble in ether, water, or alcohol, except starch, as woody fibre. This practice is as objectionable as the one we have already had occasion to comment on—namely, the use of the word "traces" to designate all the organic matter contained in water. In the present case, the actual quantity of woody fibre rarely amounts to one per cent., the tuber being mainly composed, as already pointed out, of cellular tissue.

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* Journ. de Chim. Méd., t. v. p. 508.

† Pharm. Central-Blatt für 1834, S. 695.

Jalap resin may be prepared in the following manner:—The resin, together with other extractive, is dissolved out by alcohol; to the alcoholic solution water is added, which precipitates the resin; this is washed in warm water, and re-dissolved in alcohol; or the alcoholic solution may be at once decolourised by animal charcoal; the first method, however, is the best, as by it all the sugar, &c., which may be present, as well as most of the colouring matter, is got rid of.

Jalap resin is characterised by the following properties:—It is soluble in alcohol; insoluble in water, ether, the fixed and volatile oils, including oil of turpentine; triturated with milk, it does not form an emulsion; digested in a watch-glass with sulphuric acid, a crimson coloured solution is obtained, this being a very distinctive test. From scammony resin, it is distinguished by its not forming an emulsion with milk, and by its insolubility in oil of turpentine. It is said to be sometimes adulterated with guaiacum, which, unlike jalap resin, is soluble in ether; and paper moistened with the alcoholic solution, exposed to the fumes of nitrous acid, turns blue.

According to some observers, as Buchner, Herberger*, and Kayser†, the so-called jalap resin is a compound body, and consists of two resins, the one soluble in ether, the other insoluble in that menstruum. In relation to these, we meet with the following particulars in the third edition of Pereira's "Materia Medica:"—

"*Jalapin; rhodeoretin* (from ῥόδεος, rose-red, and ῥητίνη, resin), $C_{42} H_{35} O_{20}$. This resin is insoluble in ether. Kayser obtained it by boiling purified jalap resin in ether, which took up the jalapic acid and left the jalapin. According to Buchner and Herberger, it constitutes not quite nine tenths of jalap resin; it is a transparent, colourless, odourless, and tasteless resin, very soluble in alcohol, but insoluble in water and in ether.

"It does not possess basic properties, as Buchner and Herberger supposed, but, on the contrary, possesses acid properties, reddens litmus, and is soluble in ammonia and acetic acid. If the salt which it forms with oxide of lead be decomposed by sulphuretted hydrogen, the resin is then found to have combined with the elements of water, and to have become converted into *hydrorhodeoretin*, $C_{42} H_{36} O_{21}$.

"*Jalapic acid, odorous principle of jalap* (?), constitutes thirteen per cent. of jalap resin. It is a brown, soft, and greasy substance, which reacts as an acid, has the odour of jalap, and an acrid taste.

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* Ann. der Chem. u. Pharm., bd. li p. 81., 1844.; and Pharm. Journ. vol. iv. p. 327., 1845.

† Pharm. Central-Blatt für 1831, S. 284.

By long contact with water it crystallises. It is soluble in ether, in alcohol, and in alkaline solutions, but is insoluble in hydrochloric acid. It is either a crystallisable, soft resin, or a fatty acid."

Pararhodeoretin, C_{42} H_{34} O_{18}, is obtained from the male or fusiform jalap, *Ipomæa Orizabensis*; it is soluble in both alcohol and ether, and, with sulphuric acid, exhibits the same characteristic reaction as true jalap resin.

On the Adulterations of Jalap.

Having now treated of the structure and properties of jalap, we are in a position to enter upon the consideration of its adulterations.

Exogonium purga, or true jalap, is not the only kind of jalap which grows in Mexico; there is a second, a *spurious jalap*, found there, commonly called *male jalap*, and which is sometimes exported mixed with the genuine sort. By Guibourt it has been called light or *fusiform jalap*; in English commerce it is sometimes known as *woody jalap* or *jalap wood*; while in Germany the term *jalap stalks* has been applied to the upper section of the tuber, embracing the commencement of the *stipes*, or stalk. It is the tuber of *Ipomæa Orizabensis*. (Ledanois.) "As met with in commerce it is in slices or segments, which are more fibrous or woody than genuine jalap. The cut surface is often darker from exposure to the air, and uneven from unequal shrinking in the drying process; internally it is whitish, the odour and taste being similar to, but feebler than, true jalap."

Guibourt has described a *false rose-scented jalap*, the characters of which, according to Pereira, are as follows:—"It is in tubercles which are not so dark-coloured as the genuine drug. They are deeply furrowed; the prominent parts of the furrows being white from the friction of the pieces against each other; the depressions being dark-coloured. The pieces are but slightly resinous, are amylaceous and saccharine, and have rather an agreeable sweetish odour, which Guibourt compares to that of oil of rhodium or of the rose. It possesses scarcely any purgative action; it is probably the kind known in the American market as *overgrown jalap*."

We have here then important adulterations of the very root itself, one of them at all events practised in Mexico by the dealers; we shall presently see whether jalap is not subject to further adulteration, the work of parties nearer home.

Results of the Examination of Samples.

From an examination of the analyses of *Thirty-three* samples of powdered jalap, it appeared—

That no less than *fourteen were adulterated*, or nearly one half.

That this adulteration was in all the samples of the same kind, and consisted in the addition of large quantities of *wood* in a minutely divided state.

That the wood employed in *twelve* of the samples was of the same kind; in the other two samples a different description was used, as was evident from the characters of the fibres.

That this adulteration amounted in some of the samples to at least one third, the properties and strength of the jalap being, of course, impaired to that extent.

That one of the samples yielded only 5·37 per cent. of extractive; and there is therefore much reason to believe that the resin had been previously extracted.

Mr. Scanlan gave the following evidence before the Committee on Adulteration respecting the sophistication of jalap with *guaiacum* shavings:—

"I discovered, by accident, an adulteration of powdered jalap to a great extent. I went into a druggist's warehouse one day in Wolverhampton, and saw a number of powders ready folded in 7 lb. or 14 lb. parcels. There was one I did not know; I asked the warehouseman what that one was. He told me it was powdered jalap. I said it was not powdered jalap. He insisted that it was. I said 'It is not the colour of jalap.' I took a corner of the paper and moved the powder, and I saw that the mass of powder had a different colour from the surface. I said to him, 'That is a very curious thing. It looks very like the effect which rays of light produce upon guaiacum.' The man began to laugh, and told me it was jalap root and guaiacum shavings, sent in equal weights to the mill to be ground and sold as jalap powder."

Mr. Villiers put this question to Mr. Herring, in regard to the adulteration of jalap:—

"Is it true that jalap powder is frequently adulterated with raspings of guaiacum?"—"Yes, latterly; even last week the merchants have been importing an article called jalap tops, which is merely the cuttings of the tree, not the root, and which has been sold at 2*d.* per lb."

We have now to inquire who are the parties guilty of adulterating an important article of the Materia Medica in so scandalous a manner. It is evident that the retail chemists and druggists are not the parties who practise this adulteration, since the aid of a powerful pulverising apparatus is required.

From the analyses we have made, it is also evident that jalap is not unfrequently supplied by wholesale chemists and druggists in the adulterated condition in which it is afterwards retailed; but we are not, in the majority of cases, to conclude from this circumstance that they are the parties who practise the adulteration.

As one of the great results of our investigations, we have ascertained that a large proportion of the adulterations met with are traceable to the preparers or manufacturers of the different articles of Food and Medicine.

It has already been shown that most of the spices are largely adulterated in a variety of ways. There is no doubt that many of the adulterations detected were perpetrated by a class of persons known as SPICE GRINDERS. Now, in the drug trade there exists a similar class, called DRUG GRINDERS. It is perfectly evident that an adulteration of the kind pointed out in the case of jalap can only be practised by such grinders, who alone possess the machinery necessary to carry it into operation. The drug grinders, then, would appear to be the parties guilty of the adulteration described in this report. The wholesale chemists and druggists, however, must not be entirely acquitted, for in many cases they are themselves either drug grinders, or they direct the grinders to add certain adulterants to the articles which they send to be ground.

That the drug grinders are in the habit of practising many adulterations with various articles of the Materia Medica is a matter of notoriety amongst chemists and druggists, and many members of the medical profession; and various are the statements related of the practices to which they have recourse: thus, it is said to have been a common thing to send a certain quantity of an article to be ground, with a request that it should be returned of a weight greatly exceeding that of the article sent.

In the evidence of Dr. R. D. Thomson, given before a Select Committee of the House of Commons appointed in 1838 to inquire into the "Administration of Relief to the Poor," &c., it is stated, in answer to a question by Mr. Wakley, "that it is common to send to the drug grinder eighty-four pounds of jalap to be made into a hundredweight."

We have, then, clearly established the fact of a scandalous adulteration in another most important medicine,—an adulteration, moreover, to which no reference is made in works on Materia Medica, not even in the most complete work on the subject in existence—namely, that by the late Dr. Pereira.

When to this fact we add certain other considerations, we shall perceive how great must be the variation in the strength and properties of this remedy as daily administered in hundreds of cases.

Thus, as will be presently shown, the genuine jalap tuber itself varies very greatly in strength, while this again is commonly adulterated with the spurious or male jalap, the purgative properties of which are much inferior to those of genuine jalap. The remedy for this last adulteration is to prohibit its importation.

On the Detection of the Adulterations of Jalap.

Male jalap, jalap stalks, and rose-scented jalap, differ considerably in their microscopic characters from true jalap, and also from each other.

In *male jalap* the resin is not confined to distinct cells, but occurs in masses of irregular form and size, of a bright yellow colour. The starch granules have the same form as those of true jalap, but are smaller and not so abundant.

Jalap stalks consist chiefly of very beautiful dotted ducts of large size, with dotted woody fibre, and a small quantity of starch of the same size and form as that of fusiform jalap.

In *rose-scented jalap* no distinct resin cells or masses of resin occur, but veins or streaks of coloured and apparently empty cells traverse the tuber, sections of which exhibit a mottled appearance, owing to the intermixture of the coloured and colourless cells. No starch corpuscles were found in the single sample of this description of jalap submitted to examination.

The amount of extractive obtained from powdered jalap by digestion in alcohol does not indicate with any certainty the extent of the adulteration; since, although the adulterated samples of jalap, as a rule, furnish much less extractive than the genuine drug, yet there are several exceptions to this: thus, in one genuine jalap the extract amounted to 27·36 per cent., and in another to only 19·32 per cent.; while in one adulterated jalap it was as low as 5·37, in another it reached as high as 25·84 per cent., these being the extremes of variation in the quantity of extract. This difference is due chiefly to three causes:—

First.—The quantity of resin and other matters soluble in alcohol varies very greatly in different jalap tubers, as is apparent from the following analyses:—

First Tuber.

Char.—Soft, resinous, and dark coloured; not very heavy, and slightly worm-eaten. It yielded 32·56 per cent. of *alcoholic extract.*

Second Tuber.

Char.—Firm, hard, rather whitish, and friable. Furnished 10·24 per cent. of *extract.*

Third Tuber.

Char.—Taken from the same parcel as the above, the characters being similar. It yielded 17·80 per cent. of *extract.*

Fourth Tuber.

Char.—Heavy, very hard, and of a greyish colour. It furnished 11·08 per cent. of *extract.*

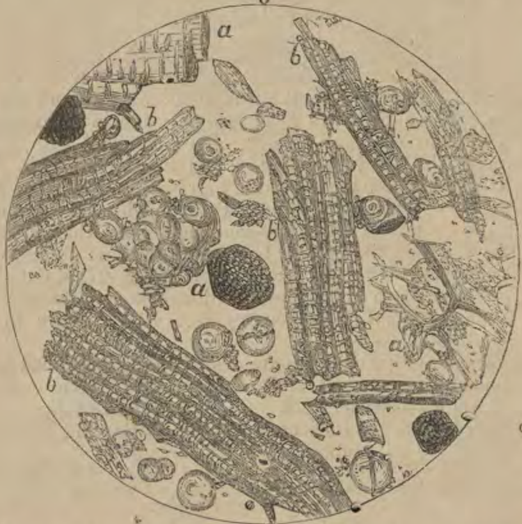
The extracts obtained from *powdered jalap*, although the results vary considerably, are yet much more uniform than those from the tuber, for in the case of the powder we obtain the average extractive of many different tubers.

Second.—If the alcohol employed contain water, a portion of the watery extract, including even gum, is likewise taken up, and so affects the per-centages.

Third.—The adulterating ingredient used, itself yields a portion of extractive.

With the view of determining the kind of wood so extensively used in the adulteration of powdered jalap, we have compared it, amongst other woods, with that of *liquorice root*, *lignum vitæ* or *guaiacum*, *satin* and *box woods*; and it is probable that, in the majority of cases, the wood employed is that of lignum vitæ, which, being a highly resinous wood, yields to alcohol a large amount of extractive; this would account for the high per-centages of extract obtained from many of the adulterated samples of jalap.

Fig. 213.



Powdered Jalap, largely adulterated with wood, probably that of *lignum vitæ* or *guaiacum*. *a a a*, cells, starch corpuscles, &c., of jalap; *b b b*, fragments and fibres of the wood. Magnified 220 diameters.

The characters of the fragments and fibres of this wood, and the appearance of a sample of jalap thus adulterated, are shown in *fig*. 213.

IPECACUANHA, AND ITS ADULTERATIONS.

IPECACUANHA, *Cephaëlis Ipecacuanha*, is a somewhat shrubby plant, the stems of which reach two or three feet in height, throwing out runners, and are furnished with leaves, seldom more than four or six in number, placed near the extremities. The roots which constitute the ipecacuanha of commerce are perennial, four or six inches long, simple, or sometimes divided into a few branches, and all presenting the strongly annulated character by which they are so readily recognised and distinguished from all other medicinal roots. Its habitat is Brazil, it being found between 8° and 20° S. lat. It grows in moist, shady situations, as valleys. The following account, taken from Martius, of the collection and gathering of the roots is given in Pereira's "Materia Medica": —

"The roots are gathered at all seasons of the year, though more frequently from January to March inclusive; and as no care is taken in the cultivation of the plant, it has become scarce around the principal towns. Those Brazilian farmers who reside in the neighbourhood of the plant carry on considerable commerce with it. The native Indians also are very assiduous in the collection of it. Those called by the Portuguese the Coroados, who live near the river Xipotó, in the province of Mínaes, as well as their neighbours the Purí, are the greatest collectors of it. They sometimes leave their villages for two months at a time, fixing their habitations in those places in which this plant abounds. They cut the roots from the stems, dry them in the sun, and pack them in bundles of various sizes and forms. Ipecacuanha is imported into this country from Rio Janeiro in bales, barrels, and bags."

Three varieties of ipecacuanha are described, distinguished by their colour — namely, *brown*, *red*, and *grey* annulated ipecacuanha. By continental writers ipecacuanha is denominated *annulated* ipecacuanha, to distinguish it from the roots of *Psychotria emetica* and *Richardsonia scabra.* These are not known in English commerce.

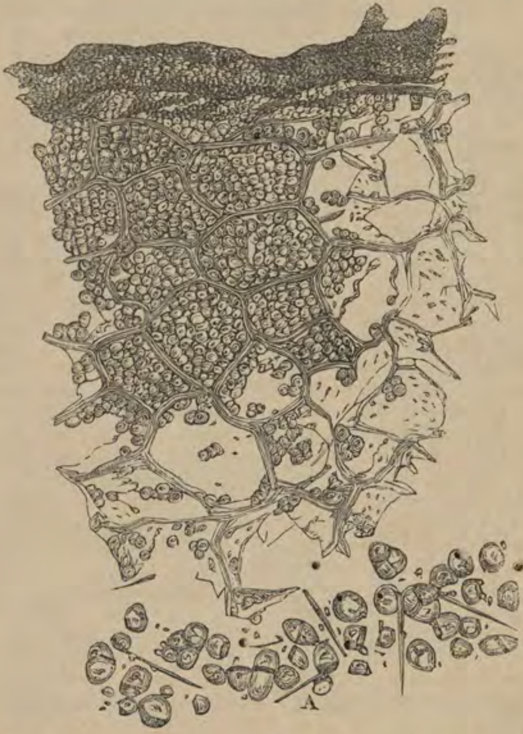
Structure of Ipecacuanha.

The substance of the root of ipecacuanha is divisible into two parts — an outer *cortical* portion, and an inner, fibrous, and *woody* part, botanically termed *meditullium.* These, in the dry root, separate very easily from each other, and their intimate structure may be determined with facility from transverse sections.

Examined under the microscope, the cortical part is seen to consist externally of cells of a deep brown colour, the parietes of which are but indistinctly visible, and which form the epidermis; the rest of the cortex is made up of colourless cells, the cavities of which are filled with minute but exceedingly distinct starch corpuscles, many of which are united in twos, threes, and even fours, and consequently are rather muller-shaped, while they are all furnished with a very distinct hilum. (See *fig.* 214.)

Fig. 214.

IPECACUANHA ROOT.

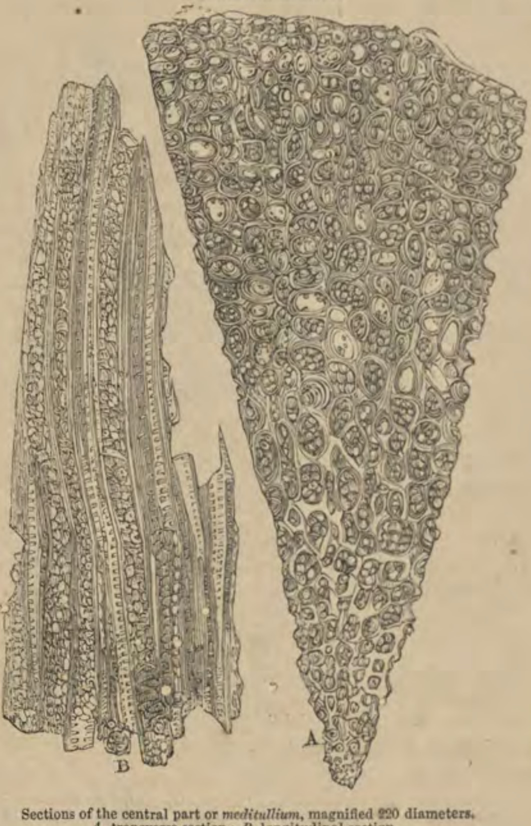


Transverse section of the *cortex*, magnified 220 diameters. *A*. Starch corpuscles of the same, magnified 420 diameters, as also certain acicular crystals; *emetina* (?) contained in this portion of the root.

In transverse sections, the central part, or *meditullium*, appears to consist of a number of slightly angular cells, of different sizes, having a radiated arrangement; those forming its outer border, as well as those of the centre, are very much smaller than the intermediate cells; these last are distinguished not only by their larger size, but their cavities are, for the most part, filled with starch corpuscles, resembling closely those of the cortex. In longitudinal sections it becomes evident that what appeared in transverse sections to be cells,

Fig. 215.

IPECACUANHA ROOT.



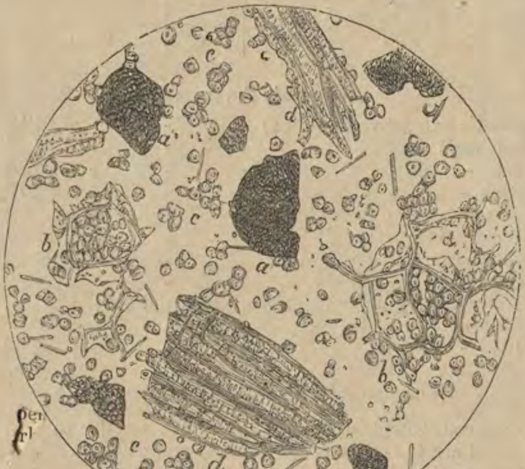
Sections of the central part or *meditullium*, magnified 220 diameters. *A*, transverse section; *B*, longitudinal section.

are really woody fibres which had been cut across; the fibres are all strongly dotted, and are remarkable for containing in their cavities an abundance of starch corpuscles. This is the only instance which has as yet fallen under our observation, in which the cavities of undoubted woody fibres have contained starch corpuscles. *Fig.* 215.

In genuine powdered ipecacuanha the whole of the structures which enter into the formation of the cortex and meditullium may be detected on careful examination, variously broken and comminuted. *Fig.* 216.

Fig. 216.

GENUINE GROUND IPECACUANHA.



a a, fragments of the brown epidermis; *b b*, cells of the cortex, containing starch; *c c*, loose starch corpuscles and crystals; *d d*, woody fibres of the *meditullium*. Magnified 420 diameters.

The structure of ipecacuanha root is therefore exceedingly characteristic.

Composition of Ipecacuanha.

The most complete analyses of ipecacuanha which have as yet been made are those of Pelletier and Bucholz.

PELLETIER'S ANALYSIS.

Brown Annulated Ipecacuanha.

	Cortex.	Meditullium.	Red do. Cortex.
Emetina - - - -	16	1·15	14
Odorous fatty matter - - -	2	traces	2
Wax - - - -	6	—	—
Gum - - - -	10	5·00	16
Starch - - - -	42	20·00	18
Ligneous matter - - -	20	66·60	48
Non-emetic extractive - - -	0	2·45	—
Loss - - - - -	4	4·80	2
Ipecacuanha - -	100	100·00	100

BUCHOLZ'S ANALYSIS.

Emetic extractive (emetina) - -	4·13
Soft resin - - - - -	2·43
Wax - - - - - -	0·75
Gum - - - - - -	25·17
Starch - - - - -	9·00
Woody fibre - - - - -	10·80
Bitter extractive - - - -	10·12
Sugar - - - - -	2·00
Extractive, gum, and starch, extracted by potash - - - -	34·80
Loss - - - - - -	0·80
Ipecacuanha - - - -	100·00

The only constituents of ipecacuanha which require to be particularly noticed are the odorous fatty matter and emetina.

The *fatty matter* is extracted from ipecacuanha by ether; its odour is very strong, and resembles that of the essential oil of horse-radish. Notwithstanding its acrid taste and pungent smell, it does not exert any considerable effect upon the stomach.

Emetina is inodorous; has a slightly bitter taste; is fusible at 122° Fahr.; very slightly soluble in cold, but more so in hot water; very soluble in alcohol, but scarcely so in ether and oils. It forms salts with acids, including tannic acid, by which *emetina* is precipitated from its solutions as a tannate.

ON THE ADULTERATIONS OF IPECACUANHA.

From the examination of *Thirty-three* samples of powdered ipecacuanha, it appeared —

That *eighteen* were *adulterated;* or more than one half.

That of these *one* contained a very large quantity of *tartar emetic.*

Two of the samples were adulterated with large quantities of *carbonate of lime* or *chalk.*

Two were adulterated with *wheat flour*, one of these also containing a proportion of extraneous *woody fibre.*

That *one* of the samples was adulterated *with a vegetable substance containing much starch.*

That *twelve* samples were adulterated with various and often considerable proportions of *extraneous woody fibre* of more than one kind.

We have now shown, that powdered ipecacuanha, like the other drugs we have reported upon, is subject to very extensive adulterations. The most prevalent adulteration detected is that with extraneous woody fibre; it will be remembered that the principal adulteration of jalap was of a similar nature. In our report on that drug we expressed the conviction that since, for the reduction of woody substances into powder in any quantity, a powerful grinding apparatus is required, drug grinders were the parties who practise this adulteration. The correspondence which ensued on the publication of that report has afforded abundant evidence of the correctness of that conviction; there is no doubt that in the case of ipecacuanha also the parties chiefly concerned are drug grinders.

Ipecacuanha, then, one of the most important medicines in the whole Materia Medica, is now proved to be adulterated to such an extent as to render its effects when administered most unsatisfactory and uncertain. This uncertainty may be shown by reference to the action of two of the samples of ipecacuanha analysed.

One sample supplied to a public hospital, and adulterated with a very large quantity of *chalk*, was repeatedly administered in doses two or three times as large as those ordinarily prescribed, without the usual effects being produced; in fact the drug was almost inert, and it was this marked inefficiency of the remedy that led to the detection of the adulteration.

Another contained nearly fourteen per cent. of *tartar emetic.* Now the effects resulting from the administration of ipecacuanha thus adulterated would be twice as severe and violent as those which ensue from genuine ipecacuanha of good quality.

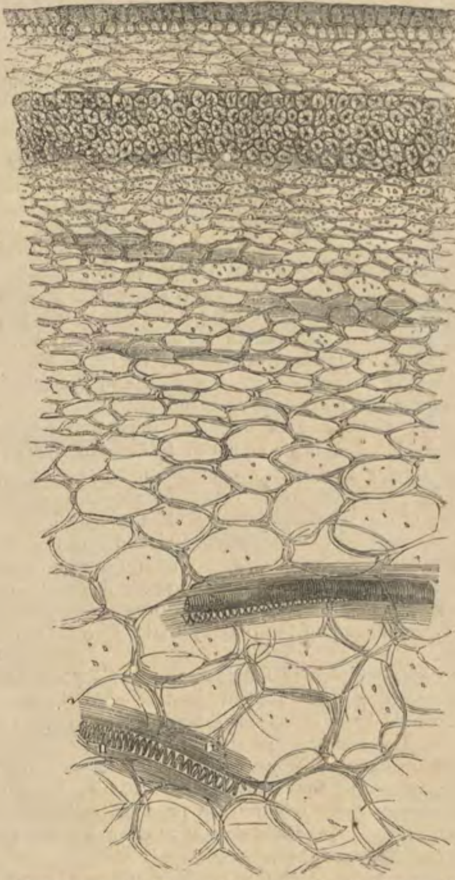
It is almost in vain that physiologists, pathologists, and chemists are constantly contributing to the advancement of the science of medicine, since the results of their labours are practically defeated and set at nought by adulterations so scandalous as those revealed in these articles on "Drugs and their Adulterations."

The time must come, and that ere long, when offences of this description will be viewed in their proper light, and men guilty of them will find themselves placed where they ought to be — at the felon's bar.

To adulterate medicines which are so frequently the salvation of life is not a simple act of dishonesty, but it amounts to a crime of the deepest dye, for which every man guilty of it will one day be answerable.

Colocynth.

Fig. 217.



Transverse section of Gourd of *Colocynth*. Magnified 100 diameters.

Since the powder of ipecacuanha is so extensively adulterated, it follows that all the other pharmaceutical preparations into the composition of which this drug enters are also adulterated, as *Pulv. Ipecac. Co. Pil. Conii Co., Pil. Ipecac. c. Opio, and Pil. Ipecac. c. Scilla.*

On the Detection of the Adulterations of Ipecacuanha.

The adulterations of ipecacuanha with *wheat flour*, *woody fibre*, or *other vegetable substances*, are discoverable by means of the microscope; those with *chalk* and *tartar emetic* by chemical methods of research.

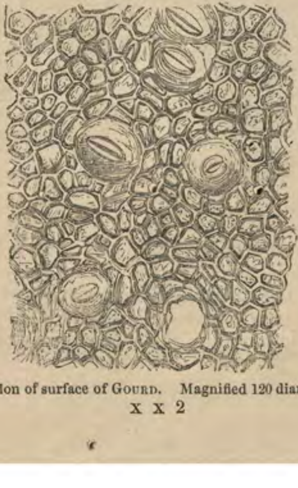
Presumptive evidence of the presence of chalk is obtained, if, on adding a little acid to the powder viewed under an inch object glass, effervescence occurs. In such cases a given quantity of the powder must be incinerated, and the ash weighed and tested for carbonate of lime in the manner already frequently described.

For the discovery of the *tartar emetic* we may proceed thus: the salt must be dissolved out of the powder with distilled water, and the solution, after being acidulated, tested with sulphuretted hydrogen; when, if tartar emetic be present, the yellow sulphuret of antimony will be formed.

COLOCYNTH, AND ITS ADULTERATIONS.

"Powdered colocynth frequently contains large quantities of the *seeds* of colocynth, and those ought never to be present; in the direc-

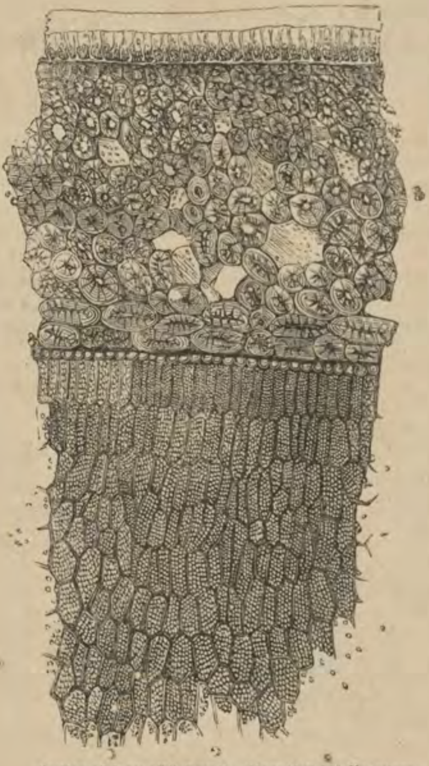
Fig. 218.



Portion of surface of Gourd. Magnified 120 diameters.

tions given for preparing powdered colocynth it is expressly stated that the seeds should be removed. I have also met with *wheat flour*, both in the powder and in the extract of colocynth; and in the latter I have detected *chalk*. Colocynth is one of the most valuable purgative medicines contained in the Pharmacopœia, and its adulteration, therefore, is a matter of considerable importance."*

Fig. 219.



Section of **Seed** of *Colocynth*. Magnified 150 diameters.

As it is impossible to detect the adulterations of colocynth without a knowledge of the structure of the gourd and seed, we append some beautiful and characteristic illustrations.

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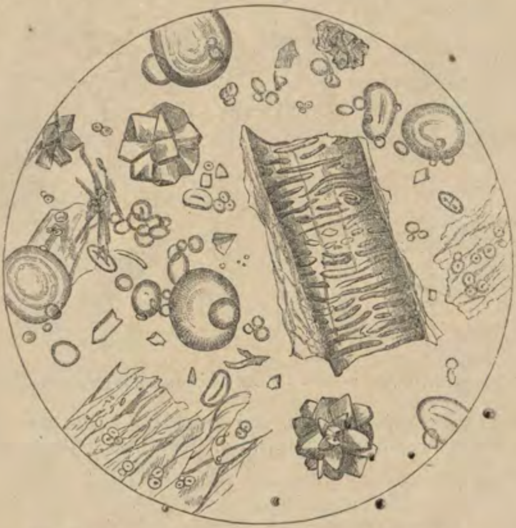
* Evidence by the author before Parliamentary Committee on Adulteration.

RHUBARB, AND ITS ADULTERATIONS.

"ANOTHER drug which I have found sometimes to be adulterated is powdered rhubarb. I have met with samples of powdered rhubarb adulterated with *turmeric*; and there is a sample upon the table which contains a considerable quantity of *wheat flour*."*

Another adulteration of Turkey rhubarb in powder is with *English rhubarb*; the medicinal action and the commercial value of which is so much inferior to that of Asiatic rhubarb.

Fig. 220.



RHUBARB, adulterated with *wheat flour*. Magnified 220 diameters.

The *dotted ducts*, *cellular tissues*, *starch corpuscles*, and *groups of raphides*, are all clearly exhibited in the figure.

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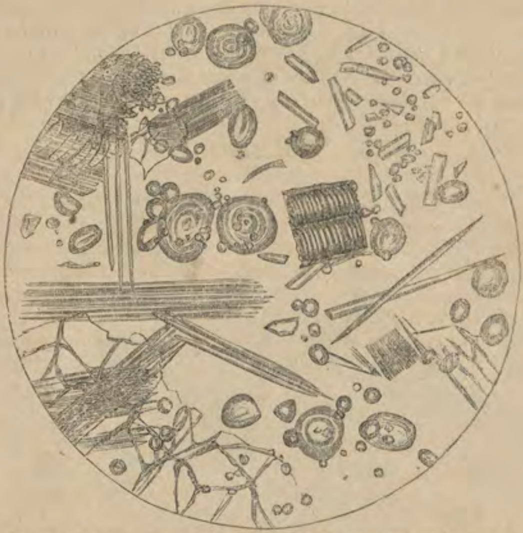
* Evidence by the author before Parliamentary Committee on Adulteration.

SQUILLS, AND ITS ADULTERATIONS.

"POWDERED squills I have found to be adulterated with *wheat flour*."*

Fig. 221.



Powdered SQUILLS, adulterated with *wheat flour*. Magnified 220 diameters.

The *large cells*, *spiral vessels*, and *groups of needle-like crystals*, characteristic of the bulb of squills, are all delineated in the engraving.

COMPOUND SCAMMONY POWDER, AND ITS ADULTERATIONS.

"ANOTHER most important medicine is the compound scammony powder. This consists of three ingredients, namely, scammony, hard extract of jalap, and ginger. Now two of those ingredients are very liable to adulteration, namely, the scammony and the powdered ginger; while *the powder of jalap* is very frequently substituted for the extract, although it is not more than about one fourth strength of the extract. Of *ten* samples of powdered scammony, I found *chalk* in greater or less proportions in all, *wheat flour* in three, and *powdered jalap* in four."*

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* Evidence by the author before Parliamentary Committee on Adulteration.

The substitution of powdered jalap for the hard extract is a most scandalous adulteration.

AROMATIC CONFECTION, AND ITS ADULTERATIONS.

"The last medicinal preparation of which I propose to speak is aromatic confection, a very valuable remedy in the treatment of diarrhœa. This should consist of cinnamon, cloves, nutmegs, cardamoms, saffron, prepared chalk, and sugar, and it is consequently a somewhat expensive preparation. I find that the more expensive ingredients are frequently omitted, and others sometimes substituted; as *turmeric* in place of the saffron, *essence of cassia* for the cinnamon, and *chalk* for part of the sugar."†

LIQUORICE, AND ITS ADULTERATIONS.

Liquorice is an article largely consumed, and furnishes an illustration of a system of adulteration which extends to a variety of other drugs and pharmaceutical preparations.

Liquorice is met with under various forms and names: thus, there is stick liquorice, the powder, the Pharmacopœial extract, the foreign extract, pipe liquorice, and Pontefract lozenges.

Stick liquorice consists of the underground stem or rhizome of a plant belonging to the genus *Glycyrrhiza*, usually in this country *Glycyrrhiza glabra*: the powder is the root ground and pulverised, while the other preparations named consist of the extract; this, in the case of pipe liquorice and Pontefract lozenges, is said to be refined.

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* Evidence by the author before Parliamentary Committee on Adulteration.

† Ibid.

The foreign extract, known as Solazza extract or juice, is considered the best; and according as it is prepared in Spain or Italy, it is called Spanish or Italian juice. We learn from Pereira that the Spanish extract is prepared in Catalonia from *Glycyrrhiza glabra*, while the Italian extract is obtained, in Calabria, from *G. echinata*. Of late years the liquorice plant has been extensively cultivated in this country for medicinal use, especially at Mitcham, where so many different kinds of medicinal plants are grown.

The constituents of the root of *Glycyrrhiza glabra*, according to the analysis of Robiquet, are, *liquorice sugar*, or *glycyrrhizin*, *starch*, *asparagin*, *resinous oil*, *albumen*, *woody fibre*, and *salts*, especially *phosphate and nitrate of lime and magnesia*. The quantities of these several constituents are not given by Robiquet, nor does he mention *gum* or *oxalate of lime* as constituents, although these abound in the juice of the root.

As before entering upon the consideration of the chemical adulteration of any article it is necessary that we should be acquainted with the proportions of the principal ingredients of which that article is composed, we instituted in the first place certain analyses of the *root*, the *powder*, and the *extract*.

The following was the composition of 100 parts of the *fresh root*:—

The Fresh Root.

Glycyrrhizin	8·60
Gum	26·60
Matter soluble in alcohol, chiefly resin	·75
Albumen	·97
Starch	22·91
Woody fibre	13·36
Moisture	26·81
Ash, 3·07 per cent.	
Total	100·00

The analysis of 100 parts of the *undecorticated powder* furnished the following results:—

The Powder.

Glycyrrhizin	10·40
Gum	43·30
Matter soluble in alcohol, chiefly resin	1·09
Albumen	1·50
Starch	24·41
Woody fibre	15·20
Moisture	4·10
Total	100·00

The analysis of the *decorticated powder* furnished nearly similar results:—

The Decorticated Powder.

Glycyrrhizin	13·0
Gum	37·1
Resin	·8
Albumen	1·80
Starch	29·52
Woody fibre	16·58
Moisture	1·02
	100·00

Five hundred parts of the fresh root furnished 175 parts of extract; while the same quantity of the powder of the dried root gave 275 parts of extract. Lastly, 100 parts of this extract, dried to a temperature of 212° Fahr., yielded 19·3 parts of liquorice sugar, and 80·3 parts of matter insoluble in alcohol, and which consisted chiefly of gum with a little albumen.

When pure and genuine, extract of liquorice is entirely soluble in water

As will be shortly apparent, the above analyses furnish some useful data, by which the quality of the different kinds of liquorice may be judged of.

Structure of Liquorice.

The *general structure* of liquorice root is very distinctive; the elements of which it consists are bundles of *woody fibre*, *cellular tissue*, *dotted ducts* or *vessels*, and *starch corpuscles*. These elements are thus arranged:—

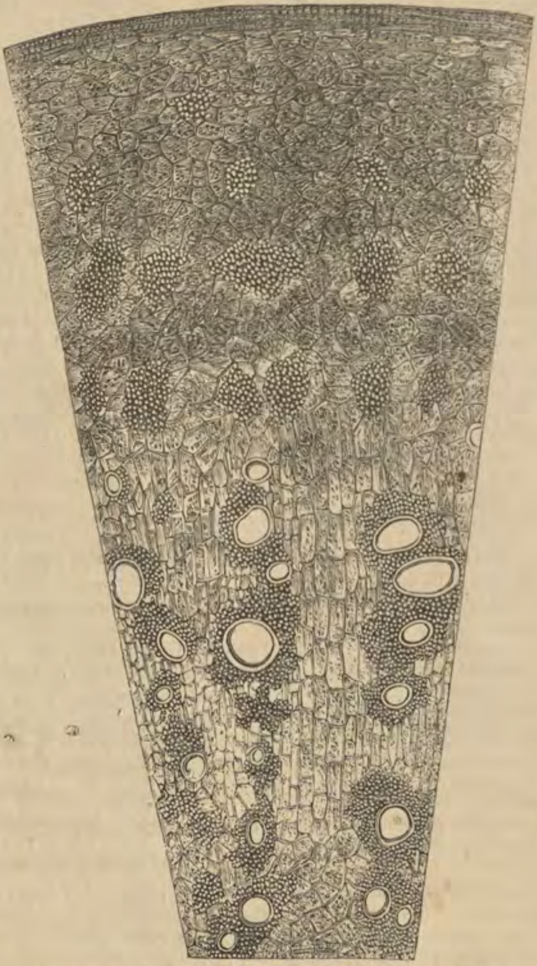
In transverse sections of the root, a linear zone is observed, usually distant from the circumference about the third of the thickness of the root. The part of the root *without* the zone is traversed by bundles of woody fibre, united together by cellular tissue; that *within* the zone is traversed by numerous dotted ducts or vessels as well as by bundles of woody fibre; while the cells of the cellular tissue which forms the basis of the root are filled with starch corpuscles.

These *starch corpuscles* are very characteristic: they are oval and small, and in many of them the central cavity of an elongated form is visible.

The *woody fibre* does not present anything remarkable in its structure; the central cavity is well marked. In sections of the older roots medullary rays may be seen. The several structural peculiarities of liquorice root are all clearly exhibited in the accompanying drawings.

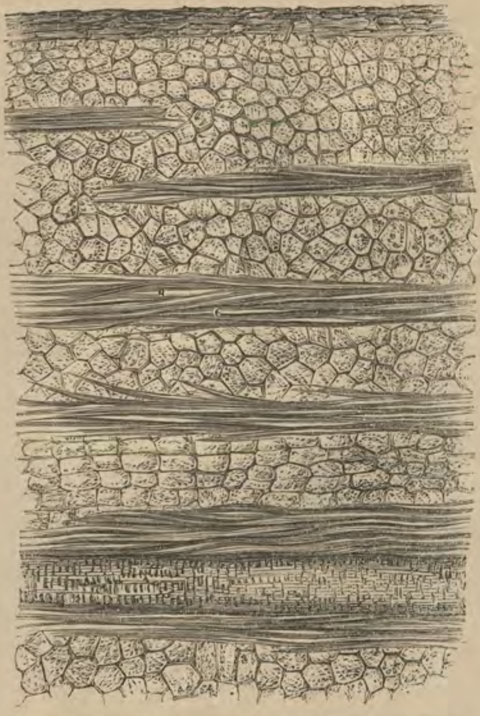
The yellow colouring matter of the root is situated almost entirely in the bundles of woody fibre, and in the walls of the dotted ducts.

Fig. 222.



Transverse section of root of LIQUORICE, showing the *dotted ducts*, the bundles of *woody fibre*, and the connecting *cellular tissue*. Magnified 40 diameters.

Fig. 223.



Longitudinal section of Liquorice Root. Magnified 40 diameters.

On the Adulterations of Liquorice.

Having thus described the chemical composition and the structure of liquorice root, the subject of the *adulteration* of liquorice may next be considered.

On consulting the works of different writers on adulteration, we have met with the following observations relating to liquorice: —

Accum * states that Spanish liquorice "is frequently nothing else than a mixture of the worst kind of *gum arabic*, called *Indian* or *Barbary gum*, imported chiefly for the use of making shoe blacking. A solution of the genuine Spanish liquorice juice is mixed with a solution of Barbary gum; and the mixture, after being inspissated to a

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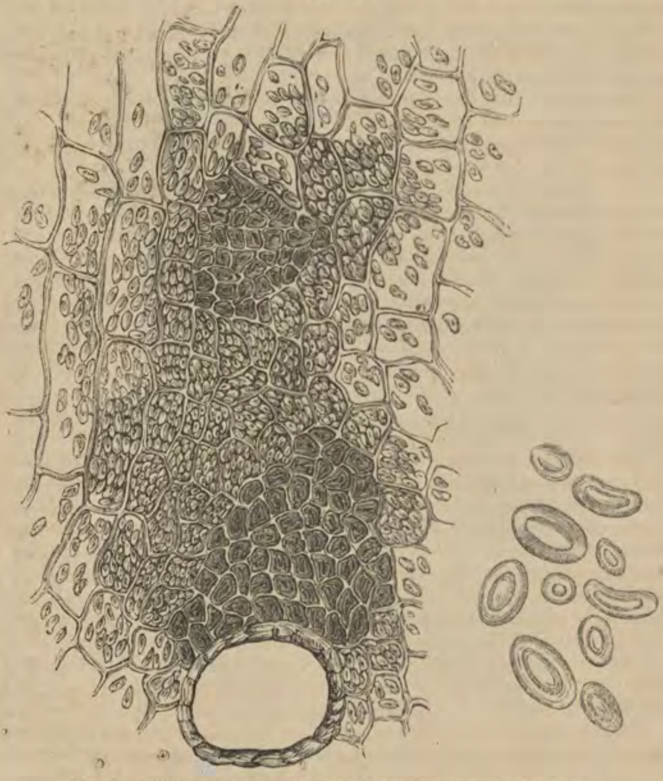
* Treatise, p. 348.

Fig. 224.



Transverse section of LIQUORICE ROOT, magnified 220 diameters, exhibiting *dotted ducts*, two bundles of *woody fibre*, the *cellular tissue*, and the *starch corpuscles*. The loose starch grains are magnified 400 diameters.

proper consistence, is again made up into cylindrical rolls, which, whilst still moist, are covered with bay leaves, and repacked in chests to resemble in every respect the genuine Spanish liquorice juice imported from Catalonia."

Brande * in his "Dictionary of Materia Medica and Pharmacy," published in 1836, remarks as follows:—

"The chief consumption of liquorice is in the preparation of the extract, which is imported from the South of Europe under the name of Spanish Juice; it is usually burned and otherwise carelessly prepared and adulterated, and often contains copper, derived from the pans in which the decoction of the root is evaporated."

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* Treatise, p. 262.

M. Chevallier* states, that "liquorice is often falsified by *starch*, and a large proportion of inert powders.' It has also been falsified by an extract which gives it the taste of hay.

"It contains likewise metallic copper, removed mechanically from the pans of that metal in which it is prepared. But it does not contain salts of copper, a conclusion which results from many experiments made by M. Villain."

"Liquorice," writes Pereira†, "as met with in commerce, however, is rarely pure. It contains the soluble principles of the root with some copper scraped off the boiler by the spatula employed to stir the extract during its preparation. Fée says that four ounces of this extract yield two drachms and a half of metallic copper; but there must be some great mistake in this statement. If the foreign extract be dissolved in water, and the solution filtered and inspissated, we obtain *refined liquorice*. But I am informed that the *pipe refined liquorice* is a very adulterated article. The *Pontefract lozenges* are made of refined liquorice, and are much esteemed."

Results of the Examination of Samples.

We will now proceed to state the results of our own examinations and analyses of liquorice, premising that genuine extract of liquorice should dissolve in water without leaving any residue, and therefore ought not to contain starch; that it should yield from about 90 to nearly 100 parts of extractive matter, according to the state of dryness in which it may happen to be at the time of analysis; this extractive matter should furnish from 75 to 85 per cent. of matter insoluble in alcohol, chiefly gum; and from 10 to 15 per cent. of saccharine matter or liquorice sugar.

The analyses of *Thirty-four* samples of liquorice, including the different varieties of *roll* and *pipe* liquorice, and *Pontefract* lozenges, carefully considered, furnish some important results.

Thus it appears that the *gum* of the different kinds of ROLL liquorice varied from 65·5 to 33·5 grains per cent.; of the *saccharine matter* from 14·9 to 8·9 per cent., part of this in some cases consisting of *cane sugar;* of the *extractive* from 75·9 to 47·1 per cent.

Of the pipe *liquorice* that the *gum* varied from 22·7 to 45·9 per cent.; the *sugar* from 19·6 to 11·0, the greater part of this consisting of *cane sugar;* and the *extractive* from 57·1 to 43·7 per cent.

Of the Pontefract lozenges the *gum* ranged from 31·5 to 25·7; the *sugar*, partly *cane sugar*, from 18·1 to 13·1; and the *extractive* from 45·9 to 43·8 per cent.

It further appears from the analyses that the whole of the *roll* liquorice furnished insoluble residues, varying in amount from 18·50 to 42·90 per cent. In *twelve* cases these residues consisted of *boiled starch*, probably *rice* (the starch present in the different samples of Solazza and Baracco extract was always of this kind); in seven samples of *wheat flour*, in one of *potato starch*, and in one of *wheat flour* and *rice*.

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* Dictionnaire des Altérations et Falsifications des Substances Alimentaires, p. 304.

† Materia Medica, vol. ii. p. 1835, third edition.

That the *pipe liquorices* likewise furnished insoluble residues, for the most part, in still larger amounts than the roll liquorice; thus the smallest residue weighed, after being dried on a water bath, 34·5 and the largest 41·0 grs. per cent. In five cases this consisted of *wheat flour*, in one of *rye flour*, and in one of *potato*, *rice*, and *wheat flours*. In five cases a small part of this residue consisted of *gelatine*, the pipes being furnished with a distinct tube of that substance.

Lastly, that the *Pontefract lozenges* furnished residues consisting of *wheat flour* (subject to the action of heat), which varied in amount from 36·5 to 39·0 grs. per cent.

The *ash* of the different samples of roll and pipe liquorice and Pontefract lozenges varied from 2·50 to 16 per cent., and consisted in several cases of foreign mineral matter; this in one instance amounted to 13 per cent. and was composed of *carbonate of lime*, or *chalk*. The ashes of the pipe liquorices in two or three cases were so deeply coloured as to lead to the suspicion that some coloured mineral earthy substance had been employed to increase their weight.

It is thus evident that the different kinds of roll, pipe liquorice, and Pontefract lozenges, are subject to very extensive adulteration, this in some instances amounting to nearly one half the article.

As a rule, the pipe liquorice and Pontefract lozenges contain a larger amount of foreign starchy matter than even the inferior descriptions of roll liquorice. Many of the pipe liquorices are in addition furnished with a thick coating of gelatine: this is sometimes of the worst quality, and but little superior to glue. The best way to exhibit the tube of gelatine encasing the pipes is to place them in cold water; the pipes will swell up and increase to two or three times their original size: when in this state, the gelatine may be easily removed.

The ingredients employed in the adulteration of the kinds of liquorice above referred to consist, then, of starch of various kinds, as wheat, barley, rye, and rice flours, and potato starch, either separately or in combination; cane sugar, gelatine, and foreign mineral matter, as carbonate of lime.

Although not immediately connected with the object of this article, we yet, when engaged in the analysis of liquorices, thought it desirable to determine how frequently and to what extent the samples were contaminated with *copper*. We detected that metal in thirteen of the twenty-one roll liquorices examined in greater or lesser amount; the quantities in three of the samples were, for the 100 grains, ·8, ·25, ·30 of a grain. Traces of copper were found in only one of the pipe liquorices, and in none of the Pontefract lozenges.

We will now pass on to state the results of the examination of the *extract* of liquorice of the *Pharmacopœia*.

Ten samples of extract of liquorice were examined; four of these dissolved nearly without residue, and were genuine: the remainder of the samples deposited insoluble residues amounting to 3, 13, 17, 9, 7, 18.5, and 33 per cent. respectively. In four cases this consisted of *boiled starchy matter*, and in one instance of *starchy matter* and *gelatine.*

The sample containing the gelatine furnished only 65.5 per cent. of extract, and the insoluble residue amounted to 17 per cent., thus leaving 18 per cent. for moisture, which large quantity the liquorice was partly enabled to retain, in consequence of its admixture with gelatine.

It is evident, from the nature and quantities of the insoluble residues, that the adulterated samples of extract of liquorice consisted of the *foreign* extract melted down.

The compilers of the Pharmacopœia were doubtless led to prescribe a form for the preparation of a genuine extract of liquorice by the knowledge of the fact of the adulteration of the foreign extract. We thus perceive to what an extent the regulations of the Pharmacopœia are evaded in this case. In further illustration of the extent to which the Pharmacopœia in this and doubtless in many other articles is disregarded, we may mention that we were only able to procure the Pharmacœpeal extract at about one-third of the chemists' shops at which we inquired for it. In one case, although we particularly requested to be furnished with the true extract, some of the foreign extract was coarsely powered while we waited, and handed to us as the article we inquired for, and for which we were made to pay twice the usual price.

In the next and last place, we will proceed to state the results of the examination of numerous samples of *powdered liquorice.*

Of *Twenty-eight samples* of liquorice in *powder* subjected to examination, *eleven were adulterated.* Of these *one* consisted chiefly of *wheat flour*, *another* contained a large quantity of *wheat flour*, *two* contained much foreign *woody fibre*, two *woody fibre* and *turmeric*, another *woody fibre* and *wheat flour*, *one* was made up chiefly of *Indian corn*, *potato* and *sago flours*, and *turmeric*, *another* of *sago*, *woody fibre*, and *much turmeric*, *another* of *East Indian arrowroot* and a little *turmeric*, and *another* consisted almost entirely of *potato flour*, a little *wheat flour*, and *turmeric*. Some of the samples likewise contained *cane sugar.*

We stated at the commencement of this paper we believed it would be found that liquorice afforded an example of a system of adulteration which extended to other and more important articles of the Materia Medica. We will now adduce some evidence to show that this is really the case.

It has been ascertained that some wholesale druggists prepare, and they nearly all keep, what are known in the trade as *compound powders.* One of these is liquorice, the genuine powder being distinguished as Pulvis Glycyrrhizæ Verus.

Other compound powders are those of turmeric, gentian, fenugreek, aniseed, cumin, and elecampane.

Those of turmeric, gentian, and fenugreek are usually prepared after the following receipts, or some modifications of them: —

Turmeric Powder.

Yellow ochre	- 1 lb.
Turmeric	- 1 lb.
Wheat flour	- 2 lbs.

Gentian Powder.

Gentian -	- 1 lb.
Linseed -	- 1 lb.
Wheat flour	- 2 lbs.
Cape aloes	- grs.

Fenugreek Powder.

Fenugreek, lb. iss.
Turmeric, ℥ xii.
Wheat flour, lb. iii.

This custom is defended on the plea that no deception is practised, and that these powders are sold as compound articles. This may be so as between the wholesale and retail dealers in drugs, but it assuredly is not the case as between these parties and the medical profession and the public: the liquorice powders, the extensive and varied adulteration of which we have just described, were sold simply as liquorice, and no acknowledgment whatever was made even in a single instance of their compound character.

It is evident that the practice of making and selling these compound powders is most objectionable; it indicates a laxity of principle, both on the part of the wholesale and retail dealers in drugs, and it is clear that the medical profession and the public are by it seriously imposed upon.

It is affirmed that it is as cattle medicines that these compounds are used. Although this is the case to some extent, yet it is very certain that they are not thus exclusively employed; besides, why should these adulterated powders be thrust down the throats of cattle?

We have now shown that liquorice in all its forms and varieties is subject to an enormous amount of adulteration, and that various substances are employed for that purpose.

Thus it has been shown —

That the whole of the foreign extracts or roll liquorices were adulterated, some to the extent of nearly 50 per cent.

That the whole of the pipe liquorices examined were also adulterated, some of them not containing one third their weight of liquorice.

That the Pontefract lozenges likewise contained but little liquorice.

That of the samples of the extract of liquorice of the Pharmacopœia, one half were adulterated; these for the most part consisting of the foreign extract melted down.

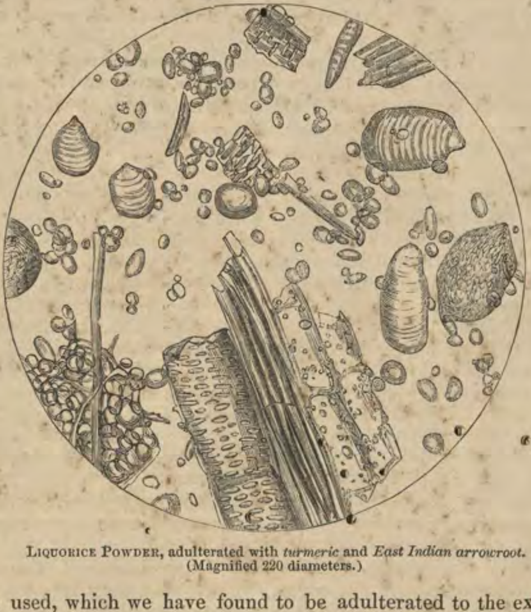
Lastly, that a large proportion of the powdered liquorices examined were adulterated, many of them containing only as much liquorice as was necessary to impart the flavour of the genuine powder.

Of the adulterations discovered in roll liquorice, some are practised by the foreign preparers of the extract, while others are the work of parties nearer home. It is, we believe, not uncommon for the foreign extract to be melted down after its arrival in this country, for the purpose of subjecting it to further adulteration. In some cases the adulterating ingredients, as flour and chalk, are so clumsily mixed with the liquorice, that particles and masses of these substances may be detected by the naked eye alone, and may be picked out with a penknife.

The adulterations of pipe and powdered liquorice described, were no doubt effected in this country.

Of the ingredients employed in the adulteration of liquorice, some are themselves liable to adulteration. This is the case with the turmeric used, which we have found to be adulterated to the extent of nearly 20 per cent. with *yellow ochre*.

Fig. 225.



Liquorice Powder, adulterated with *turmeric* and *East Indian arrowroot*. (Magnified 220 diameters.)

On the Detection of the Adulterations of Liquorice.

Since most of the adulterations of liquorice consist in the addition of vegetable substances of different kinds, the microscope affords the chief means adapted for their discovery.

The characters of *wheat flour*, *turmeric*, and *East Indian arrowroot* have already been described and delineated in woodcuts; the appearances presented by liquorice powder adulterated with the two last named substances are also exhibited in *fig.* 225.

The chief chemical adulterations practised are those with *sugar* and *chalk*, the process for the detection and estimation of the last is pointed out under the head of tea, while for the detection of *cane sugar* in liquorice powder we may proceed as follows:—

Add about two ounces of cold water to 200 grains of the powder, filter, evaporate on a water bath at a gentle heat. If cane sugar be present it will crystallise as the evaporation draws near to an end, and if now a little sulphuric acid be added, the residual mass will immediately become charred. Sulphuric acid does not carbonise liquorice sugar or glycyrrhizin but forms with it a chemical compound or sulphate.

Glycyrrhizin and cane sugar may be thus separated from each other: add excess of basic acetate of lead to a strong filtered infusion of the powder, remove the lead held in solution by means of sulphuretted hydrogen, filter, evaporate on a water bath, and when dry weigh the residue, which consists of cane sugar.

Customs duty is on—

Liquorice paste - - -	20*s*. per cwt.
Of and from British possessions -	10*s*. ,, ,,
Liquorice powder - - -	20*s*. ,, ,,
Of and from British possessions -	15*s*. ,, ,,
Liquorice root until 5th April, 1857 -	5*s*. ,, ,,
Thenceafter - - - -	free.
Liquorice juice - -	20*s*. ,, ,,

Until 1842 the oppressive duty of 3*l*. 15*s*. per cwt. was levied upon foreign extract of liquorice; this was reduced in that year to 1*l*. 7*s*. 6*d*., and in 1853 to 20*s*. per cwt., at which it now remains.

Articles.	Imported.		Entered for Home Consumption.	
	In 1854.	In 1855.	In 1854.	In 1855.
	Cwts.	Cwts.	Cwts.	Cwts.
Liquorice Paste - -	4.150	2,940	1,663	1,878
,, Juice - -	7,863	12,853	7,708	8,643
,, root - -	520	263	460	323

Liquorice not only being adulterated as imported, but being subject to further adulteration after its arrival, it is clear that the Revenue suffers a considerable loss through its sophistication.*

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* The principal part of this article was read by the author before *The Medical Society of London* some months since.

As want of space prevents us giving a separate article on each drug, we have compiled the following table, which exhibits many of the adulterations to which the more important drugs and pharmaceutical preparations are subject :—

LIST OF DRUGS AND THEIR ADULTERATIONS.

ARTICLES.	ADULTERATIONS.	AUTHORITY.
Calomel	Chalk, sulphate of barytes and white lead; fine pipe clay; white precipitate, with sulphate of lime	Normandy, Bingley, Wakley.
White precipitate	Chalk; corrosive sublimate, chalk	Thomson, Bastick.
Red precipitate	Red lead	Bastick.
Mercurial ointments	Ordinary clay mixed with prussian blue, and other substances, blue clay	Neligan, Postgate
Mercury	Lead, tin, bismuth	Normandy.
Iodine	Water, black lead, crude sulphate of antimony	Ditto.
Iodide of potassium	Carbonate of potash	Hassall, Bingley
Chromate of lead	Sulphate of barytes, carbonate of lead, chalk	Normandy.
Litharge	Earthy matter	Ditto.
Sulphate of copper	Sulphate of iron	Bastick.
Acetate of copper	Chalk; sulphate of copper and acetate of lead mixed	Normandy, Wakley.
Carbonate of lead	Sulphate of barytes, sulphate of lead, chalk	Normandy.
Calamine, or carbonate of zinc	Sulphate of barytes, chalk, ochre, carbonate of lead	Thomson.
Nitrate of silver	Nitrate of potash	Normandy.
Quinine	Salicine, Quinidine and Cinchonine; gum, starch, chalk, sulphate of barytes, stearine; chalk; sulphate of quinidine, chalk, sulphate of lime, siliceous matter, carbonate of magnesia, sulphate of magnesia, sulphate of soda	Hassall, Warington, Normandy, Sir J. Gordon, Letheby, Bingley.
Carbonate of soda	Sulphate of soda, Glauber's salt	Normandy, Scanlan.
Nitrate of potash	Common salt	Normandy.
Bitartrate of potash	Chalk, alum, sulphate of potash; alum; gypsum	Normandy, Postgate, Calvert.
Tartaric acid	Bisulphate of soda; alum	Bastick, Postgate.
Lemon juice	Large quantities of water; sulphuric, tartaric, and acetic acids	Hassall, Bingley.
Magnesia	Lime, chalk, kaolin, sulphate of barytes	Normandy.
Chloroform	Contaminated or adulterated with alcohol, chlorine, hydrochloric acid, hydrochloric ether, and compounds of mithyle, besides water and fixed substances	Blyth.
Spirits of nitre	Water; alcohol	Hassall, Thomson, Blyth, Bastick.
Sp. ammoniæ fort.	Ditto	Blyth, Thomson.
Tr. Ferri-sesqui	Ditto	Ditto, Ditto.
Hydrocyanic acid	Ditto	Ditto, Ditto.
Sp. ammoniæ aro.	Ditto	Hassall, Blyth.
Sulphuric ether	Ditto	Calvert.
Hydrochloric acid	Ditto	Hassall, &c.
Nitric acid	Ditto	Ditto.
Alcohol	Ditto	Ditto.
Rhubarb	English rhubarb; wheat flour; turmeric, flour	Warington, Hassall, Thompson.
Squills	Wheat flour	Hassall.
Senna	Leaves of cynanchum	Pereira, Bell, &c.

ARTICLES.	ADULTERATIONS.	AUTHORITY.
Linseed meal	Bran, clay, sawdust	Normandy.
Saffron	Saff-flower	Hassall.
Aromatic confection	Turmeric, cassia, excess of chalk — the more expensive ingredients being sometimes omitted	Ditto.
Sperm oil	Whale and other oils	Simmonds.
Olive oil	Nut and poppy oils	Ditto.
Castor oil	Croton oil	Hassall.
Copaiba	Linseed oil	Postgate.
Essential oils	Turpentine, fixed and volatile oils	Bastick.
Creosote	Carbonic acid	Ditto.
Burnt sponge	Prepared charcoal, common salt	Wakley.
Musk	False bags filled with dried blood; lead, dried blood, mahogany dust, and hairs of tail of horse	Quekett, Bastick.
Cochineal	Sulphate of barytes, Venetian talc	
Assafœtida	Chalk, sand, and clay	Normandy.
Copal	Gum anime, gum dammar, and common resin	Ditto.
Wax	Spermaceti	Bastick.

Many of the adulterations enumerated in the above list will be found recorded in the evidence recently given before the Parliamentary Committee on Adulteration. It might have been greatly extended, especially by reference to Pereira's "Materia Medica," and the "Pharmaceutical Journal."

CONCLUDING REMARKS.

In various parts of this work we have dwelt, influenced solely by public considerations, with some severity upon the shortcomings and incompetence of the Analytical Department of the Excise. The following remarks by Mr. Simmonds, extracted from his evidence before the Parliamentary Committee on Adulteration, point out clearly some of the chief defects of the Excise: —

"The Excise regulations, as respects articles of much consumption, appear to me comparatively obsolete, and far behind the requirements of the age. There is too much laxity and injustice on the part of the Treasury, which sanctions admixtures and adulterations in a variety of instances, as in the cases of chicory and coffee, cassia and cinnamon, wild and cultivated nutmegs, and other articles, but is most virtuously indignant at adulterated tea, tobacco, snuff, and other heavily taxed articles. The officers of the Customs are, generally speaking, extremely ill-informed as to the quality and purity of various articles imported, such as starches, oils, drugs, &c. I consider it would contribute greatly to check adulteration if scientific and thoroughly competent examining officers were appointed at each of the principal ports, whose duty it would be to examine and report upon the quality of all articles introduced, whether for manufactures or food, but especially the latter, instead of submitting samples, as is too frequently the case at present, to interested parties. In most of the principal States of Europe there exists a Board of Health, or Conseil de Salubrité (somewhat differently constituted to our Metropolitan Board), composed of eminent physicians, chemists, and engineers, appointed to watch over whatever may affect injuriously the public health and comfort."

A very important bearing of the subject of adulteration is its relation to the Revenue. This has already been considered to some extent in the Introduction to the work. Although no data exist by which the exact extent of the loss suffered by the Revenue through adulteration may be estimated, yet it is very certain that this loss amounts annually to an enormous sum of money; in fact, to several millions. The accuracy of this statement will be rendered very obvious by an examination of the following table:—

Name.	Home Consumption in 1855.	Duty.		Revenue.			Per Cent. of Adult.	Loss.		
		s.	d.	£	s.	d.		£	s.	d.
Tea - - -	63,454,035 lbs.	1	9	5,552,228	1	3	5	277,611	8	0
Coffee - - -	35,876,287 lbs.	0	3	448,453	11	9	40	179,382	4	0
Sugar (unrefined) -	7,396,029 cwts.	13	9	5,084,769	18	9	5	254,238	9	11
Chicory - - -	348 lbs.	0	5	7	5	0	30	2	3	3
Cocoa shells - -	9,967 cwts.	2	0							
Cocoa paste or chocolate	23,344 lbs.	0	2							
Cocoa - - -	4,471,561 lbs.	0	1	18,631	10	1	50	9,315	15	1
Flour - - -	1,940,219 cwts.	0	4½	28,294	16	8	15	2,244	4	4
Butter - - -	448,268 cwts.	5	0	112,067	0	0	5	5,603	9	0
Arrowroot - -	13,088 cwts.	0	4½	245	9	8	40	98	3	4
Sago - - -	108,499 cwts.	0	4½	2,034	6	10	5	103	4	4
Tapioca - - -	4,305 cwts.	3	4½	80	8	0	5	4	0	4
Pepper - - -	3,647,803 lbs.	0	6	91,195	1	1	40	36,478	0	6
Foreign vinegar -	24,105 galls	0	4½	451	9	4	20	90	5	10
Ginger - - -	21,413 cwts.	5	0	5,353	5	0	20	1,070	13	0
Cinnamon - -	42,943 lbs.	0	2	357	17	2	30	107	7	0
Cassia - - -	110,219 lbs.	0	1	459	5	0	20	91	17	0
Nutmegs - -	189,596 lbs.	1	0	9,494	16	0	15	949	9	7
Mace - - -	28,562 lbs.	1	0	1,428	2	0	10	142	8	2
Cloves - - -	220,649 lbs.	0	2	1,838	14	10				
Pimento - - -	3,535 cwts.	5	0	883	15	0				
Mixed Spice - -		1	0							
Confectionery - -	62,368 lbs.	0	2½	629	0	0	30	188	14	0
Malt - - -	33,879,381 bush.	4	0	6,775,876	4	0	30	2,032,762	17	0
Hops - - -	82,368,306 lbs.	0	2	686,402	11	[illegible]	20	205,920	15	3
Hops, foreign - -	39,020 cwts.	45	0	87,795	0	0	20	17,559	0	0
Spirits - - -	21,957,275 galls.	8	0	8,782,906	0	0	25	2,195,726	5	0
Rum - - -	3,224,292 galls.	8	2	1,316,892	9	8	25	329,148	2	5
Brandy - - -	1,526,221 galls.	15	0	1,144,660	15	0	15	171,699	2	3
Annatto - - -	2,966 cwts.			14,765	0	0	50	7,382	10	0
Wine, foreign - -	6,180,985 galls	5	6	1,699,757	2	6	25	424,939	5	7
Tobacco - - -	30,275,001 lbs.	3	0	4,541,250	3	0	20	908,280	0	7
Ditto, manufactured, and snuff - -	218,583 lbs.	6	0	65,574	18	0	20	13,114	19	7
Opium - - -	56,067 lbs.	1	0	2,803	7	0	30	841	0	0
Liquorice paste - -	1,878 cwts.	20	0	1,878	0	0	30	563	14	0
Ditto juice - -	8,643 cwts.	20	0	8,643	0	0	40	2,592	18	0
Ditto root - -	323 cwts.	5	0	8,015.	0	0	20	16	3	0
		Total		-			-	7,078,268	9	4

It appears, therefore, that the total loss to the revenue arising out of adulteration, amounts to the enormous sum of 7,078,268*l.*, an estimate which in the main is doubtless correct, and which is amply sufficient to demonstrate that the subject of adulteration is one of high interest to the statesman and the financier.

The per-centages given represent very nearly the extent of adulteration prevailing in the years 1851, 1852, and 1853; at the present time, in the case of some of the articles enumerated, it is less in consequence of the exposures and denunciations of adulteration made in our Reports published in "The Lancet," and in the evidence before the Parliamentary Committee on Adulteration. On the other, the calculations are based upon the returns for the year 1855, the consumption of most articles in that year being greatly reduced in consequence of the war. It should also be remembered that great reductions have been made of late years in the duties upon most articles of consumption, so that it may be fairly assumed that a few years ago the proportionate loss to the revenue was much greater than at present.

The adulteration of *Malt* is put down at 30 per cent.; this is intended to include not only its direct adulteration, but mainly to represent the diminished consumption of malt arising out of the adulteration of malt liquors, so generally and extensively practised. The same remark applies to *Hops*.

The adulteration of *Sugar* is set down at 5 per cent.; this includes the sugar used so extensively in the manufacture of sugar confectionery, and which, as has been shown, is liable to considerable adulteration.

For the increased revenue yielded the last three or four years by many articles, Government is assuredly indebted to ourselves, to Mr. Wakley, and the Committee of the House of Commons on Adulteration.

The calculations of Mr. P. L. Simmonds, given to the Parliamentary Committee on Adulteration, establish the same important fact. It may be observed, however, of these calculations, that they are certainly on the average much too low. He made the loss to amount in the year 1854 to upwards of three millions.

If the loss of the Revenue is so great, what must be that of the Public?

We cannot more appropriately conclude this work than in the following words, taken from a very able article on the author's book entitled "Food and its Adulterations," contained in the Quarterly Review:—

"We have now shown enough to convince the public that the grossest fraud reigns throughout the British public commissariat. . . . . It remains to be seen whether the Government is able and willing to stay this gigantic evil and national dishonour."

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